

AD-A153 166

①

THE 2nd ANNUAL REPORT
ON
THE UTILIZATION OF
PEOPLE-RELATED NAVY RDT&E

FY 1978

April 1979



#1-AD-A066333

Contract No0244-79-C-1764

DTIC FILE COPY

Assembled by

Navy Personnel Research and Development Center
San Diego, California 92152

DTIC
ELECTE
APR 26 1985
S D

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

85

4

25

034

REPRODUCED AT GOVERNMENT EXPENSE



DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON, D.C. 20350

IN REPLY REFER TO
Ser 987/239860

16 AUG 1979

From: Chief of Naval Operations
To: Distribution List

Subj: Annual Report on the Utilization of People-Related RDT&E

Ref : (a) UNSECNAV Memo of 26 September 1978, Subj: Navy Manpower;
Personnel and Training Research, Development and Studies
Program

Encl: (1) Second Annual Report on the Utilization of People-Related
RDT&E

1. Reference (a) provides that one goal of subject RDT&E is to ensure that its products are appropriately implemented by users throughout the Department of the Navy. To further that goal, enclosure (1) is promulgated and forwarded for information and action as appropriate.
2. It is requested that each addressee review enclosure (1) to identify:
 - a. Completed RDT&E that might be used in his command or office.
 - b. RDT&E that has been utilized but not reported.
3. Additional utilization is encouraged. Direct contact should be made to the appropriate organization to obtain assistance. Either additional utilization, or unreported instances of utilization, should be reported to the following address:

Commanding Officer
Navy Personnel R&D Center
Code P201
San Diego, CA 92152

D.F. Emerson

D.F. EMERSON
VADM USN
Director, Research, Development
Test and Evaluation

Robert B. Baldwin

Robert B. BALDWIN
VADM USN
Deputy Chief of Naval Operations
(Manpower, Personnel and Training)
Chief of Naval Personnel

Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By _____	
Distribution/ _____	
Availability Codes	
Dist	Avail and/or Special
A-1	



Distribution List:
(see next page)

REPRODUCED AT GOVERNMENT EXPENSE

Distribution List:

A1	(Immediate Office of the Secretary)
A2A	(Department of the Navy Staff Offices)
A3	(Chief of Naval Operations)
A4A	(Chief of Naval Material)
A5	(Bureaus)
A6	(Headquarters U.S. Marine Corps)
21A	(Fleet Commander-in-Chief)
24	(Type Commanders)
26F	(Operational Test and Evaluation Force)
26H	(Fleet Training Group)
26Q	(Nuclear Weapons Training Group)
26V	(Landing Force Training Command)
26KK2	(Petroleum Training Unit Pac)
26DDD	(Fleet Combat Systems Training Unit)
C4D	(Office of Naval Research Resident Representatives)
C4F50	(Education & Training Program Development Center Branch)
C4K	(Project Managers under the direct Command of the Chief of Naval Material)
C4L	(Director of Navy Laboratories)
C34	(CINCUSNAVEUR Shore Based Detachments) (Human Resource Management Detachment, Naples, Rota, and Edzell only)
C55	(Occupational Development and Analysis Center)
C58	(CNET Shore Based Detachments) (NAMTRADETS, NATTC Det, CTSPTEP Det and NAVSUBTRACENPAC Det only)
FF5	(Safety Center)
FF30	(Manpower and Material Analysis Center)
FF38	(Scol Academy)
FF48	(Human Resource Management Center)
FH	(Shore Activities under the Command of the Chief, Bureau of Medicine & Surgery, less FH3 & FH25)
FJ	(Shore Activities under the Command of the Chief of Naval Personnel)
FKA1	(Systems Command Headquarters)
FKA6	(R&D Activities)
FKR	(Shore Activities under the Command of the Commander, Naval Air Systems Command)
FR1	(Chief of Naval Reserve)
FR9	(Reserve Readiness Command Region)

Ser 987/239860

FT

(Shore Activities under the Command
of the Chief of Naval Education
& Training)

V6

(Marine Air Reserve Training
Command)

V8

(Recruit Depot)

V12

(Marine Corps Development & Education
Command)

FOREWORD

This is the second annual report on the Navy's people-related research, development, test, and evaluation (RDT&E) efforts. The primary focus is on significant research from FY 78. This report emphasizes the application of people-related RDT&E and includes (1) examples of results already in use, (2) advances in the technology base, and (3) current activities designed to increase RDT&E applications.

People-related RDT&E funding is based on expectations that the results of such research will enhance the Navy's operational readiness by improving the management and application of Navy personnel and weapon systems. Recently, however, the Department of Defense (DOD) and the Congress have asked for examples of R&D application and for evidence that such efforts enhance readiness. This report provides such evidence.

The Navy's people-related RDT&E program is far too extensive to be covered in this brief document, so the examples presented here are intended to show significant and interesting cases of application or technology base advancement. The examples are not unique, but representative. The intended audience is not researchers, but rather DOD policymakers, members of Congressional committees, and Navy operational and training commands.

This report was compiled by the Navy Personnel Research and Development Center, San Diego, Ca.; and the manuscript was prepared by BioTechnology, Inc., Falls Church, Va., under contract N00244-79-C-1784. Appreciation is expressed to each contributing command. Comment and inquiries from sponsoring and user commands are encouraged.

CONTENTS

	<i>Page</i>
INTRODUCTION	1
MANPOWER AND PERSONNEL	5
A National Survey of the Intentions of 18-25-Year-Olds to Enlist.	7
Computerized Adaptive Ability Testing.	8
Implementation of Armed Services Vocational Aptitude Battery (ASVAB) Validation Research.	9
A Computer Model to Determine Accessions from Various Commissioning Programs.	10
Improving Data Entry to Large Computerized Personnel Files.	10
Improving Personnel Records Management in the Marine Corps.	11
A Computer Model to Forecast the Impact of Changes in the Fleet/Shore Balance.	12
A Model for Sea Duty/Shore Duty Rotation.	13
Retirement Analysis Model (RAM).	14
HUMAN FACTORS ENGINEERING	17
Measuring Air Combat Performance.	19
Effects of Operator Interface on System Cost Effectiveness.	20
Man/Computer "Voice Interactive Systems" Technology.	21
Target Acquisition and Target Visibility.	22
Crewstation Assessment of Reach (CAR) Model.	23
Operator/Maintainer Equipment Handling Evaluation.	24
Aids for Human Decisionmaking.	25
Visibility Requirements for Underwater Information Displays.	26
Navy Technical Information Presentation System (NTIPS).	28
EDUCATION AND TRAINING	31
Testing Out a Shipboard Computer-Managed Instructional System.	33
A Computer-Assisted Individual Study Program.	33
Development of a Tactical Action Training Environment (TATE).	34
Automated Testing of Performance in Computer-Managed Instruction.	35
USMC Rotary-Wing Air Navigation Training.	37
Desktop Computer Used to Enhance Submarine Tactical Training.	37
Instructional Quality Inventory.	38
Computer-Based Training Systems.	39
Evaluating Methods for Equal Employment Opportunity Training.	41
Recruit Training Preview Reduces Attrition.	41
Establishing Liaison with the Nation's Schools.	42

CONTENTS (Continued)

	Page
SIMULATION AND TRAINING DEVICES	43
Universal Infantry Weapons Trainer	45
Advanced and Synthetic Firefighting Simulators	46
Visual Technology Research Simulator (VTRS)	48
Instructional Support System for Aviation Simulators	49
A Navy-Designed Training Program for the New SH-3H Helicopter	51
R&D COORDINATION	53
The 1979 Interservice Conference for the Coordination of People-Related R&D	55
Technology Advisory Group (TAG)	55
Technology Exchange	55
Top Management Action to Enhance Utilization of People-Related R&D	56

INTRODUCTION

This report contains descriptions of people-related research which has been utilized or has contributed to the technology base that supports operational needs. People-related research is concerned with research, development, test, and evaluation (RDT&E) to enhance the attitudes and performance of Navy personnel. Within the Department of Defense, this type of research is funded under the training and personnel technology (TPT) area.

The quality of people-related research has rarely been questioned; its utilization, on the other hand, has been questioned by both the legislative community and DOD policymakers.

In considering the fiscal year 1979 DOD budget request, the House Armed Services Committee recommended some significant reductions in the people-related research area, stating that "the committee has expressed concern for several years over the utility of research and development in training and personnel technology programs." More recently, in March 1979, the research and development subcommittee of the House Armed Services Committee held special hearings on the TPT area. The Chairman of that subcommittee, Congressman Richard Ichord, opened the hearings with a statement to the effect that the purpose of the hearing was not to decide whether the appropriation requested was too high or too low, but to examine how this area enhances defense.

The Navy has several endeavors under way to optimize the utilization of people-related research. One of these endeavors is the publishing of an annual report on the utilization of people-related RDT&E. This report is the second in that series and generally reports on R&D efforts for FY 1978 which resulted in utilization or in major progress in the technology base to support near-term utilization. The R&D activities presented in this report are organized into four technical areas:

- Manpower and Personnel
- Human Factors Engineering
- Education and Training
- Simulation and Training Devices

Within each technical area, important Navy people-related RDT&E projects are described. In general, the descriptions emphasize the relationship of the project to an operational need, its utilization, and payoff or potential payoff.

The Need for People-Related RDT&E

The need for people-related RDT&E has increased in recent years due to (1) the decision to sustain our military manpower with an all-volunteer force (AVF) policy, and (2) the greater complexity and sophistication of new weapons and support systems. Controversy over the effectiveness of the all-volunteer force policy is, in itself, a basis for people-related RDT&E. Issues related to obtaining, preparing, and retaining personnel in today's AVF pose a great many problems for policymakers. Policymakers, in turn, depend on the researchers for evidence on which to base policy.

Perhaps more important is the fact that there is an ever-increasing disparity between the complexity and sophistication of modern military weapon systems and the capabilities of the military personnel in the all-volunteer Navy. In short, the complexity and sophistication of modern military hardware is increasing at a rate greater than ever before, while the capability of our military personnel to operate and maintain these systems is, by even the most optimistic accounts, just barely keeping pace. This hardware-personnel mismatch generates a demand for answers from people-related RDT&E.

The continually growing complexity and sophistication of new systems in the Navy must also be viewed in the light of the vigorous acquisition program conducted for them. The Navy HARDMAN project (HARDMAN is an acronym derived from the terms "military hardware" and "manpower procurement") issued a report in 1977 which included the following observation:

The U.S. Navy, like the other military services, engages in a weapon systems acquisition program on a continuous basis. The purposes attached to the acquisition program include modernization, upgrading, and replacement of equipment. Navy weapon systems procurement is dominated by large systems, particularly ships and aircraft. In addition, there are numerous smaller systems which are also subject to the acquisition process. All told, there are currently 700 different Navy projects involving approximately \$90 billion in procurement.

It appears that the all-volunteer force will be with us for some time and, collaterally, the influx of new

systems into the Navy will be quite substantial for many years to come. The effects of both these policies will be to increase the need for people-related RDT&E.

The Importance of People-Related RDT&E

The importance of people-related RDT&E can be expressed from both the policymaker's point of view and the Navy military needs point of view. For an example of the policymaker's point of view, consider statements made recently by two key policymakers.

Dr. Ruth M. Davis, Deputy Undersecretary of Defense for research and advanced technology, made the following remarks before the Subcommittee on Research and Development of the Committee on Armed Services of the House of Representatives on 23 March 1979.

This Committee knows that people are needed to operate and maintain the modern weapon systems within the Military Services. The readiness of our operational forces requires that they be properly trained to carry out their assigned tasks. Indeed, manpower accounts each year for a larger share of the defense budget than does the procurement of weapon systems. Therefore, it is very important that we constantly improve our ability to select, train, manage, and support our manpower in the most effective way possible. Our program in Training and Personnel Technology accounts for about four percent of the total Science and Technology (S&T) Program of the Department of Defense.

Because it is such an important program, I have given it my close personal attention. I have met and participated in meetings with the commanding officers and technical directors of the laboratories of the Military Services in this area. I have visited many of the laboratories. The work underway is good; I have tried to make sure that Service efforts are coordinated and directed towards our most pressing problems.

The Honorable David E. Mann, Assistant Secretary of the Navy (Research and Engineering Systems), made the following statement before the House Armed Services Committee's Subcommittee on Research and Development on 7 March 1979. The subject of his address was Navy research, development, test, and evaluation for FY 1980.

The Chief of Naval Operations has given one of his highest priorities to people-related programs. We have responded to previous Congressional guidance in several ways:

1. Concern has been expressed over the utility of this work.

a. We are publishing an annual report of utilization of Navy people-related Research and Development findings to encourage more use by the Navy and other Services of the results of the efforts.

b. We have given a more commanding role to the Deputy Chief of Naval Operations (Manpower, Personnel, and Training) to ensure development of proper requirements for Research and Development, and the employment and utilization of its results.

2. Concern was expressed that "continuing projects" implied lack of progress. Actually, they masked progress. To correct this deficiency, work has been divided into projects with definite beginning and ending dates that will clearly show progress.

3. Finally, the Navy has restructured its efforts into the four categories requested by Congress: Manpower and Personnel, Training and Education, Human Factors Engineering, and Training Devices and Simulation.

The importance of people-related RDT&E from the Navy military needs point of view can be illustrated by considering a few of the major changes or needs in the Naval Air Systems Command and the Naval Sea Systems Command.

Naval aviation has changed dramatically in recent years. Many factors have contributed to these changes. Display requirements have increased by 30%, due to the increased number of sensors, weapons, and cockpit instrumentation. Available cockpit space has continually diminished; for example, the console and panel area has changed from 1750 square inches in the F-4 to 1300 square inches in the F-15 to 850 square inches in the F-18. At the same time, the physical dimensions and capabilities of personnel have become more variable. There is increasing pressure to reduce crew size, which increases the risk of inappropriate automation. Safety and survival factors are still major problems, since the fatality rate of pilots ejecting from aircraft is approximately 15% despite major investments in escape system hardware; hundreds of millions of dollars worth of aircraft are also lost every year in accidents.

Naval ships, too, are experiencing dramatic changes, even though the number of ships in the active fleet has decreased. The new ships are larger, more capable, and more complex. There is little comparison, for example, between a destroyer of WWII vintage and today's nuclear-powered cruiser. Similarly, the nuclear-powered fleet ballistic missile submarine of today is vastly different from the WWII diesel electric

submarine. Changes in Navy ships have had a significant impact on ship maintenance and the personnel who must perform this maintenance. Measures of ship size and complexity such as displacement, shaft horsepower, and electrical generating capacity indicate that on a per-hull basis greater resources are required for ship maintenance today than several years ago. For example, both displacement and shaft horsepower have increased approximately 45% today over 1970 average ships. The average weekly man-hours per hull required for planned maintenance of surface ships has gone up from approximately 1,000 in 1970 to 2,000 or more today. This doubling of maintenance man-hours places a greater burden on people-related R&D concerned with maintenance technical manuals and with the selection and training of maintenance personnel.

One further example of the increased importance of people-related RDT&E is the difference in training required to ready a crew for a destroyer today and 30 years ago. WWII-type destroyers took 900 man-weeks of training to get the crew ready; the new 963 type destroyer takes almost 6,000 man-weeks of training per crew.

Although people-related RDT&E is a small part of the total RDT&E budget (less than 1%), research properly focused and utilized can result in immense leverage for effectively operating and maintaining our new weapon and support systems.

Utilization and Technology Base Advance

While this report focuses on utilization, it also recognizes the importance of advancing the technology base used to plan for utilization. In essence, this means initiating research projects that will advance the technology base and minimize the gap between operational needs (utilization) and the people-related technology base available to meet those needs. Consequently, a significant portion of the budget for training and personnel technology is dedicated to advancement of the technology base. The real payoff for people-related RDT&E projects must, therefore, include considerations of research progress as well as utilization. Since the terms "utilization" and "technology base advance" are fundamental to this report, definitions of these areas are provided below.

● *Research Utilization or Application*

Any change involving:

- Initiation or modification of regulations, orders, doctrines, policies, or manuals.

- Development or change of courses of instruction or training programs.
- Development or modification of equipment.

● *Technology Base Advance*

Any advancement of the state-of-the-art involving:

- Basic research: Scientific study and experimentation directed toward increasing knowledge and understanding in those fields related to long-term national security needs. It provides fundamental knowledge for the solution of identified military problems and furnishes part of the base for subsequent exploratory and advanced developments in defense-related technologies and new or improved military functional capabilities. (Funds for this type of research come from Program Element 6.1.)
- Exploratory development: All efforts directed toward the solution of broadly defined problems; short, major development programs with a view to developing and evaluating technical feasibility. (This type of development is funded under Program Element 6.2.)
- Advanced development: All projects that have moved into the development of hardware for test. The prime result of this type of effort is proof of design concepts rather than the development of hardware for service use. Projects in this category have a potential military application. (This level of development is funded under Program Element 6.3.)

The planning for utilization of people-related RDT&E must be deemed even more crucial when we recognize that a slow, practically unnoticed change has occurred in the weapon system acquisition process. Whereas in the past the requirement was to acquire weapons to arm the man, now the need is to acquire people to man the weapon. It is possible that we have reached a point—or will shortly—where even if the budget says that we can afford exotic new systems, a simultaneous determination will have to be made as to whether we can afford them in terms of the qualitative and quantitative requirements for people.

An unmanned, unusable weapon system is not a military deterrent!

MANPOWER AND PERSONNEL

DoD defines this area of People-Related RDT&E as follows:

"Development of techniques/methods for utilizing available personnel resources through improved selection, job assignment, organizational analysis and management techniques to meet combat available and projected force needs."

The Navy must continually improve its manpower and personnel processes. These processes include: estimating manpower requirements (especially for new systems); developing advanced methods of recruiting, classifying, and assigning officers and enlisted personnel; increasing productivity; retaining qualified people in the Navy; obtaining accurate personnel data; and estimating the supply of personnel from various sources. A major focus at the present time is on developing computerized models for planning and for evaluating policy alternatives.

Projects in this category include:

- A National Survey of the Intentions of 18-25-Year-Olds to Enlist
- Computerized Adaptive Ability Testing
- Implementation of Armed Services Vocational Aptitude Battery (ASVAB) Validation Research
- A Computer Model to Determine Accessions from Various Commissioning Programs
- Improving Data Entry to Large Computerized Personnel Files
- Improving Personnel Records Management in the Marine Corps
- A Computer Model to Forecast the Impact of Changes in the Fleet/Shore Balance
- A Model for Sea Duty/Shore Duty Rotation
- Retirement Analysis Model (RAM)

A NATIONAL SURVEY OF THE INTENTIONS OF 18-25-YEAR-OLDS TO JOIN THE MILITARY

Need

Recent population projections issued by the Census Bureau predict a steady decline in the military's prime manpower pool: young men from 17 to 21 years of age. That trend is expected to continue well into the 1990s. One way for the Armed Services to deal with the anticipated shortage of manpower is to utilize women on an expanded basis. Increasing the participation by women would include widening the range of their assignments in terms of both site (ships, aircraft, combat areas) and type of work ("nontraditional" areas like mechanics and electronics).

Personnel planners need to know (1) the number of women who would join the service under various conditions, and (2) the background and attitudes of these potential enlistees. Accurate, current information on such issues can best be obtained through a random national survey.

Performing Activity and Program Elements

The project was initiated and administered by the Navy Personnel Research and Development Center, with funding provided under Program Element 63707N. At the request of the Department of Defense, the survey was expanded to include all the services; additional support for this effort was provided by the Office of the Secretary of Defense (Manpower and Reserve Affairs).

Approach and Results

A nationwide survey of both men and women in the 18-25 year age group was conducted by random telephoning. An independent advertising company was commissioned to conduct the survey; questionnaires and analytical techniques were established jointly by the contractor, NPRDC, and the Joint Marketing and Advertising Research Committee (which includes representatives of the Air Force, Navy, Army, and Marine Corps). A large majority of those interviewed were women. The primary objectives of the study were (1) to gain reasonable estimates of the numbers of young men and women interested in entering the military services under each of four conditions and (2) to find out some pertinent demographic and attitudinal characteristics of this interested population. A secondary objective was to measure the effect that a greater participation by women might be expected to have on men's interest in joining the military.

It was found that men and women differed surprisingly little in their degree of interest in joining the military under current conditions. About 14 percent of the women and 16 percent of the men expressed a

positive interest in joining the armed services today. The relative preference, by military branch, shown by women is displayed in the table below.

Percentage of Women
with Positive Interest in Enlistment

	Current Conditions	Option I	Option II	Option III
Air Force	9.8%	13.8%	10.8%	10.1%
Navy	7.9%	11.1%	8.5%	8.4%
Army	5.6%	7.4%	5.6%	5.6%
Marine Corps	4.7%	3.9%	3.4%	4.7%

The positive interest of women increased when an option (Option I) was presented involving training and service in traditional male job areas. Interest fell somewhat when a similar option (Option II) involving service on ships, aircraft, or combat support areas was offered; however, the level of interest remained as high or higher than interest levels under current conditions. A third option, completely equal treatment with men (same jobs/training, service on ships or aircraft, and in combat areas) resulted in responses similar to those found for the previous option.

Interested women appeared to have had more formal education than their male counterparts, but they had generally taken fewer courses in technical fields like mechanical drawing and electronics. They tended to be more oriented than the men toward the "people" aspects of a job, and less inclined toward working with machinery and electronics.

The men surveyed expressed greater interest in joining the military when there was a stronger likelihood of serving with women. The one exception was the possibility of serving with women in combat—here interest declined, yet not below the level for current conditions.

Utilization/Technology Base Advance

Until the National Survey of the Intentions of Women to Join the Military was completed, little objective data existed on the female military supply pool. The results of the survey are now a part of the marketing network developed by the Defense Manpower Documentation Center for use by the recruiting commands of each of the branches. The Navy Recruiting Command has implemented survey findings in its resource allocation and recruitment-goal procedures. The results of the survey were communicated in writing to OSD M&RA and to the recruiting and marketing community of each of the branches through a nine-volume report prepared by the contractor and through a Navy Personnel Research and Development

Technical Report summarizing and interpreting key findings. Survey findings and methods were communicated orally to the personnel chiefs of each of the branches and to representatives of the Joint Marketing and Advertising Research Committee through a series of briefings held May-June 1978.

Payoff/Potential

The Defense Manpower Commission (DMC) estimated that in a period of rapid economic growth from 1975 to 1985, the force-level shortfall in males would increase to 20%, or approximately 19,000 individuals by 1985. A DMC econometric study sug-

gests that a 17% increase in pay would be required to eliminate the 19,000 shortfall. But by making up for this shortage, new sources of manpower would eliminate the need to increase pay. And, even if no shortage were to develop in the present manpower pool, the DMC study suggests that an increase in supply sources would eliminate the need for competitive basic pay increases. Expansion of the supply pool to include more women is also likely to result in an improvement in the overall quality of enlistments (1) because of the relatively high educational level of the women who would join, and (2) because better qualified men might be induced to join if women were active in more areas of service.

COMPUTERIZED ADAPTIVE ABILITY TESTING

Need

The Navy has a need for more efficient assessment of the mental abilities of its personnel and its potential recruits. An ongoing basic research interest has been in the use of computers to achieve a higher degree of efficiency in such testing than is possible with current testing techniques. A recent memorandum from the Assistant Secretary of Defense for Manpower, Reserve Affairs, and Logistics to his counterparts in the services calls for planning the implementation of computerized testing in the services' testing program for applicants.

Performing Activity and Program Elements

This project was performed by the Office of Naval Research (ONR) (Program Element No. 61153N) and the Defense Advanced Research Projects Agency (Program Element No. 62709E).

Approach

Initially, this research effort developed the mental-test theory underlying adaptive testing—which is the computer testing technique used here—and the analytical tools required to apply the theory. In adaptive testing, the computer selects successive test questions on the basis of the individual's previous answers. The current focus of the project is on solving technical problems entailed in putting the analytical tools to work. Research in the project has included an evaluation of both the techniques for choosing test items and the methods of scoring to be used. These evaluations have shown that adaptive tests can be up to half as long as standard tests without a loss in testing accuracy.

Utilization/Technology Base Advance

Exploratory development of this testing approach is under way in every service and at least one civilian agency (the Civil Service Commission). The Personnel Research Division of the Air Force Human Resources Laboratory (AFHRL), the Army Research Institute for the Behavioral and Social Sciences, the Defense Advanced Research Projects Agency, and the Technical Training Division of AFHRL are all sponsoring research on the use of adaptive testing to measure proficiency and achievement. The Navy Personnel R&D Center (NPRDC) is engaged in research to evaluate the feasibility and merits of adaptive testing for selection and classification testing in a Marine Corps recruit population. A prototype software system for computerized test administration has been developed, and several hundred Marine recruits have taken the experimental tests. Parallel with this practice work, NPRDC is conducting computer simulation research to determine optimal procedures for adaptive testing, to be incorporated in an advanced prototype testing system. NPRDC has also developed a set of engineering specifications for a multi-terminal computer adaptive testing system using a high-resolution graphics display.

The Department of the Navy is leading an inter-service task force, with the U.S. Marine Corps having specific responsibility to plan implementation. Additionally, the research on adaptive testing has been the subject of two meetings sponsored by the Office of the Under Secretary of Defense for Research and Engineering to keep potential users, such as the Navy Recruiting Command, informed of developments in the field.

ONR also organized periodic informal meetings of its own contractors in this area, as well as formal conferences involving the support and participation of other services and interested agencies.

Payoff/Potential

Adaptive testing can have an impact wherever mental assessments are needed. Assessments can be made, not only of basic abilities, but also of progress in training, of proficiency, and of readiness for particular tasks. Computerized adaptive testing results in

economies in both the time and the cost of testing, and in improved accuracy of assessment.

The most near-term application of adaptive testing seems to be for selection and classification tests. Adaptive testing here could achieve economies in the cost of administration and supplies, and minimize problems with test security. Tests are scored instantaneously, and are compatible with a computer-based career-counseling system under study by NPRDC. These benefits could not only lead to better selection and classification but could also provide diagnostic information for later use in remedial instruction.

IMPLEMENTATION OF ARMED SERVICES VOCATIONAL APTITUDE BATTERY (ASVAB) VALIDATION RESEARCH

Need

The Armed Services Vocational Aptitude Battery (ASVAB) is the only set of mental ability tests available to the Navy for selecting enlisted personnel and assigning them to the various entry-level technical training courses. It is imperative that the ability of the ASVAB to screen and differentially classify applicants and enlistees be monitored and verified, and, in addition, that information be maintained regarding the best combinations of tests in the ASVAB to be applied for assignment to diverse schools.

Performing Activity and Program Element

The Navy Personnel Research and Development Center was tasked by the Bureau of Naval Personnel (BUPERS) to perform this effort. Costs were reimbursed from OMN funds.

Approach and Results

Scores of all enlistees on the ASVAB are obtained. Data are also obtained on the performance of students at BE/E and Class A schools. Comparisons are then made between various correlations of ASVAB test scores and school achievement records.

Throughout FY 78, NPRDC also submitted information to BUPERS about the accuracy of the ASVAB tests in predicting school performance. This information was in the form of correlation tables between tests and combinations of tests and school performance, and expectancy tables showing the numbers qualifying on a variety of selection standards and the actual proportion of school enrollees passing or failing on each. Recommendations for changes in ASVAB selection standards were offered whenever appropriate.

Utilization/Technology Base Advance

BUPERS, which is now the Navy Military Personnel Command (NMPC), has used this information to decide which school selection standards to implement.

In addition to validity information across-the-board for most of the Class A schools, NPRDC performed special studies prompted by requests or problem statements from NMPC or CNET. Among these were:

a. Recommending a selection standard to be used in qualifying personnel for Basic Electricity and Electronics (BE/E) schools. The standard was implemented by NMPC in some BE/E schools.

b. A study of a proposed selection standard for Anti-Submarine Warfare (AW) school. The findings supported the proposed standard, and it has been implemented.

c. A study of a proposed change in the selection standard for Polaris Electronics (PE) school. The results of this study led to a decision by NMPC not to adopt the proposed standard.

Payoff/Potential

The information produced in this research enables personnel administrators to make better decisions in assigning personnel to training situations and to be alert to the need for—and the direction of—changes required in classification methods. The matching of personnel with occupational pathways is thus much improved, which results in fewer school failures and less waste of training time and resources.

A COMPUTER MODEL TO DETERMINE ACCESSIONS FROM VARIOUS COMMISSIONING PROGRAMS

Need

The Navy meets its officer manpower requirements by accessions from several commissioning programs. Each community develops its own accession plans yearly, without coordinating with other communities. Coordination is accomplished only when an overall accession planner finally collects all the plans and negotiates an all-Navy plan. For the commissioning programs to be more effective, all-Navy planning considerations, such as the intercommunity tradeoffs, need to be considered earlier in the planning process. In addition, the planning methods now being used in these programs fail to account for differences in the rate of loss from among the various commissioning sources and specialty areas (communities). These differences in "loss behavior" mean that the Navy sometimes finds it difficult to meet numerical requirements at points along the career path. Planning for manpower requirements should also consider more points along the career path than a single "choke point" in that path.

Performing Activity and Program Element

A model was developed by the Navy Personnel Research and Development Center to help make these improvements in the accession planning process. Funding was provided under Program Element 63707N.

Approach and Results

A goal programming approach was used to develop an Accession to Individual Designators (AIDS) model

that takes into account requirements and inventory (by length of service) in each community, as well as a variety of planning constraints. The model determines the number of officers to be accessed from each commissioning source into each specialty area over a multi-year planning horizon. Test runs with the initial model, emphasizing requirements in the submarine community, produced accession totals in agreement with those developed by that community planner. On the basis of these and other initial results, officer accession planners have supported the use and further development of the AIDS model.

Utilization/Technology Base Advance

The initial AIDS model, focusing on the unrestricted line (URL), is in operation at NPRDC and will be used to support officer accession planning studies in the current fiscal year. The model will also be installed this year on a computer system to which Navy planners have direct access, and will soon be extended to other communities and commissioning sources. It will be available for full-scale officer accession planning by FY 80.

Payoff/Potential

The AIDS model allows the operating levels of commissioning programs to be more accurately determined and more easily evaluated, which should provide a force better shaped to meet the manpower needs of the future.

IMPROVING DATA ENTRY TO LARGE COMPUTERIZED PERSONNEL FILES

Need

Accurate records are vital to effective personnel management. The larger the organization, the more accuracy becomes essential because more decisions are made at places remote from the person affected. Personnel records that contain errors can lead to misassignment of individuals, failure to give or receive prompt notification of promotion, and incorrect pay.

Incorrect or untimely action has three adverse effects. First, such actions harm the morale of the personnel involved. Second, such actions impair the readiness of operational units and the efficiency of the

total organization. Third, money is lost or wasted when pay is incorrect or payroll deductions are in error.

One of the most serious problems in maintaining accurate records is in the data entry process. Typically, information is taken from one form filled out in longhand and transcribed to computer-readable form. Current practice regarding pay forms and status forms relies on the technology of Optical Character Recognition. When a form is first typed, a special font is used so that the type can be read directly onto magnetic tape by passing the form through a machine similar to those used in banks to read checks.

This personnel data entry activity is done at the Personnel Office at each Navy base. Often, errors are not detected until the copy is processed centrally. Some of these errors can be corrected on the spot, but too often the originating agency must be contacted to determine what the correction should be. In such cases, delays of 60 days or more can ensue, and correcting errors becomes a very costly process.

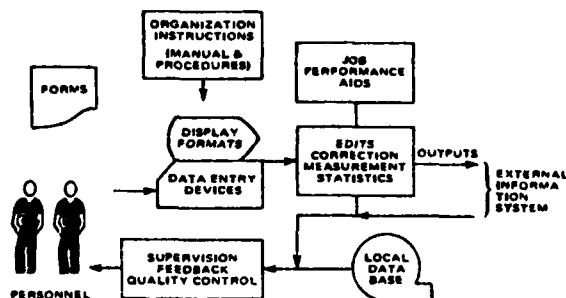
The objective of the project reported here is to support the design of a new system that will minimize the generation of errors at the point of original data entry.

Performing Activity and Program Element

The research within this project is being done by the Navy Personnel Research and Development Center. The Program Element is 63707N.

Approach and Results

A new system for handling data entry is being developed by the Bureau of Naval Personnel. The general approach is to use a direct entry mode, rather than Optical Character Recognition. The direct entry mode would employ a computer terminal with local storage and display capability so that the preparer could review his/her work on the spot and immediately make editorial corrections before transmission to the local, regional, or central computer. This sequence of steps is illustrated by the diagram below.



Source Data Entry Module (SDEM)

The work at NPRDC is to test variations on this basic scheme in order to find the best alternatives for display formats, input procedures, edit instruction codes, the provision of reminder messages on the display, and other essential parts of the design. Tests are being conducted through the use of functioning mock-ups of the various configurations. Ultimately it should be possible to test even such advanced techniques as voice entry as a design option.

Present results indicate that direct entry operations are more accurate, but are actually slower than with the existing procedure. The slower pace is not only disadvantageous in itself, but also leads to low user acceptance. More complete automation is apparently required, and can be tested in the mock-up using a minicomputer.

Utilization/Technology Base Advance

In the present case, utilization of the research results is guaranteed because the results feed directly into the system design effort under way at the Bureau of Personnel. In one sense, this is an engineering support activity.

However, the project also provides an opportunity to advance the technology base in its own right. Both display and control aspects of man-computer systems are chronic problems. Many organizations both public and private are developing devices that are intended to ameliorate these problems. The ability to evaluate these developments in an entirely objective manner using the in-house laboratory capabilities represented by the mock-ups could be the key to improved design of man-computer systems of many kinds.

Payoff/Potential

The project is in its early stages, so that present payoff is quite limited. The practical potential is substantial, however, considering that current outlays are in the neighborhood of \$2.5 million (approx. 180 person-years) for correcting errors that are detected by computers in the Navy's two main processing centers.

IMPROVING PERSONNEL RECORDS MANAGEMENT IN THE MARINE CORPS

Need

Personnel records are the basis for many actions in the Marine Corps, both at Headquarters, USMC, and in operating commands. At headquarters, policy planners use personnel data to compute attrition rates, promotion rates, desertion rates, and other important statis-

tics. Because such information is constantly changing and because much of it originates in the field, needed manpower analyses have typically been delayed. The conventional records system does not preserve old information—which has consequently made historical analyses impossible to derive. A personnel data base that is more readily accessible would unburden field

commanders, who must now compile and report such information, and improve the enlisted personnel assignment process.

Performing Activity and Program Element

The Office of Naval Research sponsored the development of this project. Funding was provided through Program Element 61153N.

Approach and Results

A Statistical Retrieval System/Rate Generator (SRS/RG) was developed to supplement the Marines' very large personnel data base. It includes a separate, variable-length record for each marine, which grows as significant events take place in his career (such as promotions, transfers, offenses, etc.).

Utilization/Technology Base Advance

The SRS/RG makes possible the very rapid computation of statistical rates like those mentioned above. Computation is also more accurate, because all changes to the data base are done at headquarters by automated means. Rates are, for the first time, easily calculated by occupational specialty and organization. The enlisted assignment branch uses SRS/RG to better manage the assignment of marines.

Payoff/Potential

Field commands are no longer required to manually compute rates such as those mentioned. Headquarters planners now have a fast and powerful method that permits them much more flexibility and innovation in querying manpower files. It is also possible, for the first time, to generate historical information and determine trends very rapidly.

A COMPUTER MODEL TO FORECAST THE IMPACT OF CHANGES IN THE FLEET/SHORE BALANCE

Need

The Navy must regularly determine the effect that changes in fleet size or configuration have on the shore establishment and its requirements for manpower. Conversely, the Navy needs to know the mixes of fleet elements that can feasibly be supported by an existing shore establishment structure. The lack of adequate quantitative tools for determining the effect of specific fleet changes on shore manpower resources often results in a reliance on across-the-board manpower reductions. However, such proportional cuts may produce out-of-proportion consequences in terms of fleet support. For example, manpower reductions at the Naval Supply Center in San Diego over the past five years, while proportional to cuts in fleet size, resulted in a 27 percent degradation of fleet support, measured in terms of the percentage of issues delivered on time.

Support manpower requirements are affected not only by the size and mix of the fleet, but also by its operating tempo and by indirect fleet demands channeled through other shore activities. What is needed is a tool to adequately measure total fleet impact on shore requirements.

Performing Activity and Program Elements

The project was performed by the Navy Personnel Research and Development Center. Funding was provided under Program Element 63707N.

Approach and Results

A computerized input-output model (CIOM) was developed, capable of forecasting the workload at various shore activities given a specified fleet configuration. The initial version of this mathematical model represented the fleet-support demand network of the Eleventh Naval District. Several CIOM test runs were made to gauge the effects of changes in fleet size, mix, and operating tempo on the workload requirements of various shore activities. Test forecasts of fleet/shore interactions for two recent years (FY 76 and FY 78) were accurate to within one and two percent, respectively.

Utilization/Technology Base Advance

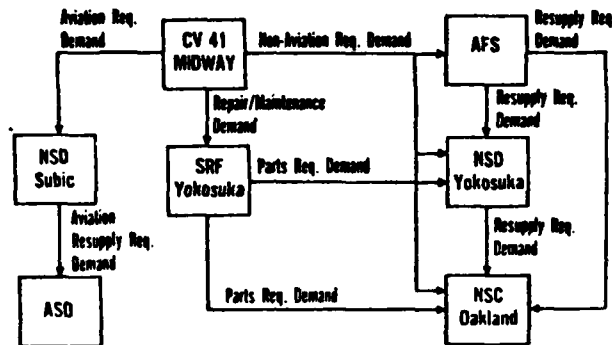
In FY 78, CIOM was used to project tug workload requirements at the Naval Station, San Diego, through FY 79. The Naval Station has used the workload projection to justify their budget request for FY 80. The Naval Supply Center at San Diego used CIOM's forecast of FY 79 requisition demands on their activity in support of their FY 79 budget submission.

CIOM has had particularly successful applications within the Naval Supply Systems Command (NAVSUP). Fleet requisition demand rates of ships by type (e.g., destroyer, frigate) and status (in port, deployed, or in overhaul), developed for the CIOM were provided to NAVSUP. This information proved rele-

vant in such NAVSUP studies as the homeporting of ships at Newport, a hypothetical shift in homeporting of ships between San Diego and Long Beach, and the effect of changes in fleet size/location on all Naval Supply Centers in general.

The supply sector of the Eleventh Naval District's model is being expanded to include all Pacific fleet supply support. Activities that will be included in the

expanded model are: the Naval Supply Centers at San Diego, Oakland, Pearl Harbor, and Bremerton; the Naval Supply Depots at Subic Bay, Guam, and Yokosuka; and all Pacific fleet supply ships (see figure). Utilization of the results of this expanded effort is expected by all four Pacific fleet supply centers, NAVSUP, and the Commander-in-Chief, Pacific fleet.



*Fleet-Support Demand Network
(Ships Operating in Japan or Korea)*

Payoff/Potential

The Deputy Comptroller of NAVSUP has written the Commanding Officer of NPRDC to express his own command's appreciation for the research and development of CIOM. "Of particular interest to [NAVSUP],," he writes, "have been the results of studies completed on the effects of fleet size on the Naval Supply Center, San Diego...[which have] saved many hours of research on the part of my staff." He closed by saying that "the initiatives undertaken by NPRDC are extremely worthwhile and I look forward to receiving the results of future studies."

A Navy-wide input-output (I/O) model has potential applications at various levels of planning and pro-

gramming. For example, it would allow more accurate determination of the size of the shore establishment (in terms of workload and manpower) needed to support a specified fleet configuration (number of ships/aircraft, mix, operating tempo). Conversely, it would be useful in determining what alternative fleet configurations a given shore establishment could support. A Navy-wide version of the I/O model would represent a significant refinement of the Navy Resource Model (NARM) currently being used, which estimates support requirements as a percentage of operational manpower. Significant financial savings could be anticipated in administrative operations. Improvements could also be expected in fleet readiness and the responsiveness to external changes in budget, warfare technology, and operational commitments.

A MODEL FOR SEA DUTY/SHORE DUTY ROTATION

Need

In justifying its manpower requirements, the Navy must answer many questions about billets and rotation needs. Such questions include:

- How many shore billets are required for timely sea/shore rotation under different rotation policy alternatives?

- How many billets do not require military personnel for reasons other than rotation?
- How many women can be absorbed into a rating without impacting male rotation?
- What is the number of billets of a particular rating that can be "civilianized" without having an adverse effect on sea/shore rotation?

Performing Activity and Program Element

The model was developed by the Navy Personnel Research and Development Center, with funding under Program Element 62763N.

Approach and Results

An interactive sea/shore billet rotation model (BILROT) has been developed. The BILROT model can calculate the number of sea and shore billets for each rate/rating that, given a prescribed rotation policy (e.g., 3 years at sea/3 years at shore), would produce equal flows of personnel between sea and shore duty. The model can determine if, and how many, shore billets can be converted to civilian or enlisted women positions; and, it can suggest appropriate tour lengths given current or future numbers of sea and shore billets. The results are provided for the current month and fiscal year and for five future fiscal years, the latter being useful in POM development. Finally, the model permits flexibility in policy specification and control over the reports generated.

Utilization/Technology Base Advance

The Deputy Chief of Naval Operations (Manpower, Personnel, and Training), is currently using the model to address congressional and Program Objectives Memorandum (POM)-inspired questions concerning manpower resources and rotation requirements. The model has been particularly useful in identifying enlisted shore billets that are not necessary for rotation purposes and could therefore be civilianized.

Payoff/Potential

By suggesting sea and shore billet complements for each rate/rating that achieve balanced rotation flows between sea and shore duty, the BILROT model should help improve morale, now often adversely affected by rotation uncertainty. From the billet manager's point of view, the model gives a significantly longer planning horizon than before, as well as the quick-response capability necessary to address many rotation/billet management inquiries.

RETIREMENT ANALYSIS MODEL (RAM)

Need

Recently, substantial changes in the U.S. military retirement system have been proposed by various groups. While the primary goal is the reduction of total personnel costs (particularly retirement costs), a highly significant consideration is the change in retention among active duty personnel. For the Navy enlisted force, which already faces retention problems in some technical ratings, the implementation of a new retirement system without considering its effect on force behavior could easily lead to personnel shortages and a degradation of force quality.

Consequently, before any new retirement system is implemented, the cost and behavior effects must be forecasted as accurately as possible. Both short-run and long-run effects have to be known in order to determine periods of high costs and/or turbulent force behavior.

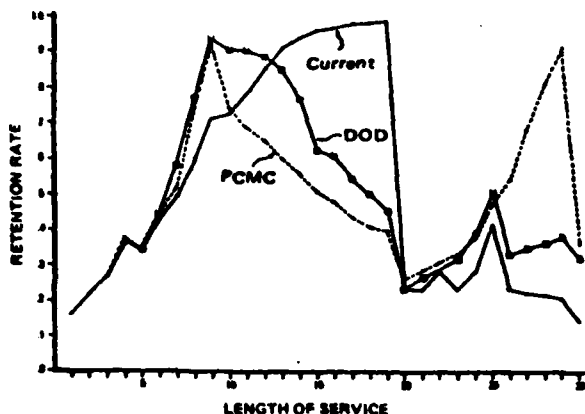
Performing Activity and Program Elements

The model was developed by the Navy Personnel Research and Development Center, under Program Element No. 62763N.

Approach and Results

The objective was to develop a computer model to allow the user to enter the particulars of a retirement system and receive, within seconds, the forecasted cost and behavior effects for enlisted personnel. NPRDC developed the model, called the Retirement Analysis Model (RAM), in two stages—one for each of the two kinds of effects to be predicted.

The first stage consisted of an interactive computer model for forecasting active duty and retirement costs up to 50 years for virtually any type of retirement system. In addition, the steady-state (or long-run) effects are presented. This model thus allows cost comparisons of alternative retirement systems for both the transition period and the period after the enlisted force becomes stabilized. Early results have indicated that many retirement alternatives, including those suggested by the President's Commission on Military Compensation (PCMC), offer prospects of reduced enlisted personnel costs in both the short and long run (see figure).



Predicted Voluntary Retention Rates for Current, President's Commission on Military Compensation (PCMC), and DOD Retirement Systems

Part two of RAM was developed to forecast long-term enlisted behavior under the economic incentives of alternative retirement systems. A statistical relationship between behavior and current economic incentives was established so that future behavior could be forecast using a different set of economic incentives, for an alternative system. Results of the analyses of various alternatives indicated that many of them would seem to substantially change enlisted continuation behavior patterns, as depicted in the graph.

Utilization/Technology Base Advance

RAM is currently operational on a UNIVAC 1110 at the Naval Ocean Systems Center in San Diego, California. Because numerous retirement proposals have been formulated, RAM has been used by the Bureau of Naval Personnel to assist in formulating the Navy's retirement position. In particular, the results of RAM are used to look at whether the long-term behavior forecast for a particular retirement system will provide the Navy with an "optimal" enlisted force as characterized by a years-of-service profile. If not, then one or two of the economic incentives of the retirement plan could be changed in order to achieve the optimal force behavior. RAM provides this kind of analysis interactively within seconds.

Payoff/Potential

RAM provides Navy analysts with the necessary information for determining which retirement system best fits the Navy's needs. The potential payoff in terms of cost savings and acceptable force behavior could be quite large, if contrasted with the costs and loss of force quality that might result if the "wrong" retirement system were to be implemented.

Also, once a retirement system is chosen for implementation, RAM can then be utilized to forecast expected costs and behavior, which would allow Navy budget and program managers to prepare for resulting changes. Additional work is currently being performed to extend RAM to the forecasting of behavior for separate enlisted occupational groups as well as for the officer community.

HUMAN FACTORS ENGINEERING

DoD defines this area of People-Related RDT&E as follows:

"Development of improved methods and technologies for the analysis, design and evaluation of equipment/systems for safer and more efficient operation and maintenance."

The Navy needs equipment designed so that people can do their jobs faster, more accurately, and more safely when they operate, maintain, or control that equipment. The Navy's Research and Development program in Human Factors Engineering is involved in all systems, from their initial formulation to test and evaluation. The program develops technology that will be applied by practicing human-factors engineering specialists in various development agencies and contractor firms.

Projects in this category include:

- **Measuring Air Combat Performance**
- **Effects of Operator Interface on System Cost Effectiveness**
- **Man/Computer "Voice Interactive Systems" Technology**
- **Target Acquisition and Target Visibility**
- **Crewstation Assessment of Reach (CAR) Model**
- **Operator/Maintainer Equipment Handling Evaluation**
- **Aids for Human Decisionmaking**
- **Visibility Requirements for Underwater Information Displays**
- **Navy Technical Information Presentation System (NTIPS)**

MEASURING AIR COMBAT PERFORMANCE

Need

Judging the proficiency of pilots in air combat tactics has been a difficult and highly subjective process. As a result, the learning of Air Combat Maneuvering (ACM), which depends heavily upon a pilot's knowledge of his progress and mistakes, has been limited by the skill of the individual instructor in evaluating and explaining a trainee's performance. Development of the Air Combat Maneuvering Ranges (ACMR) has been a major step toward the standardization of ACM training, but it has reemphasized the need for objective and accurate measurement and feedback to the trainee of how well he is doing and what his problems are. This effort, initiated at the request of the Deputy Chief of Naval Operations (Air Warfare), uses data from instrumented aircraft flying on the ACMR to develop a scoring system for ACM performance and to define criteria for when to launch a missile. The objective is to improve ACM learning and missile launch accuracy through an immediate diagnosis of trainee strengths and problem areas.

Performing Activity and Program Element

Development of ACM performance measures is part of a project for Improving Air Combat Performance, conducted by the Naval Aerospace Medical Research Laboratory under Program Element 63701N.

Approach and Results

First, the different requirements to be met by an ACM performance measurement system were defined (e.g., training evaluation and revision, mission debrief, selection criteria). Then a set of candidate measures were developed that identified critical events leading up to the point of launching a missile or being fired upon by an attacker. Extensive real-time data were collected at the ACMR and analyzed to determine key variables to be included in the measurement system. After validation against ultimate success (kill/no kill), these measures were used to analyze the performance styles of pilots from different squadrons and from different experience backgrounds. Distinct differences in attack style were identified that were highly related to success in ACM attack.

Utilization/Technology Base Advance

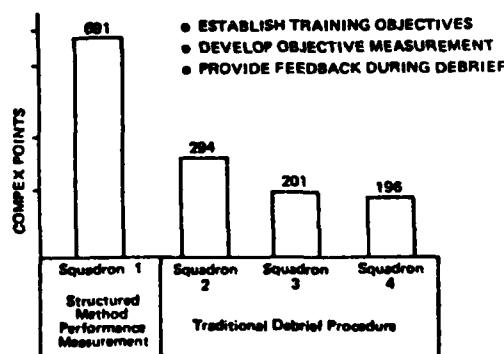
Use of the measurement system as a trainee debrief technique was tested during an ACM exercise by providing feedback to one of four squadrons of F-4 pilots. The other three squadrons used conventional training approaches. Compared to these traditional training methods, structured feedback using performance measurement resulted in:

- a three-fold superiority in kill ratio (2 to 1 vs. 6 to 1)
- a 76% decrease in missile envelope recognition error.

Standardized ACM performance measures can serve as a criterion for the evaluation of different training approaches. Measures of overall ACM proficiency provide an accurate way to test undergraduate training effectiveness, and are an ideal standard by which to validate new tests and methods for making the initial selection of aviators.

Payoff/Potential

Although findings on ACM performance improvements have not yet been fully implemented, results show sharp increases in aviator ACM proficiency (see figure). The benefits of improved combat performance are obvious: savings in equipment cost and lives of aircrewmen, as well as greater mission effectiveness. Savings in time and training costs are also gained by the more judicious early selection made possible by these standardized ACM performance measures.



Impact of Performance Measurement Feedback on Training Effectiveness in Air Combat Maneuvering

EFFECTS OF OPERATOR INTERFACE ON SYSTEM COST EFFECTIVENESS

Need

The effectiveness of any automated system is limited by the ability of human operators to use it. We can no longer assume that increasing automation and hardware sophistication will result in improved performance. If a new system does not take into account the abilities of the operator, it may be unable to perform its mission; it may in fact be less effective than an earlier, simpler design. Even when mission performance is improved, the cost of the new system may exceed the value of the performance gain. Therefore, the Navy needs methods to predict the consequences of interactions between systems and their operators. Current methods for predicting the effectiveness of new designs involve system modeling, but they omit the critical role played by the operator interface. As a result, automated systems may not achieve their designed capability because crewmembers cannot exploit them fully.

Since decisions must be made early in the design cycle, there is a need for computer models that include a realistic simulation of operator characteristics, and are able to:

- Determine whether a proposed system or system change results in a net gain of effectiveness over cost, when the operator's job is considered.
- Choose the most cost-effective among alternate ways of achieving a specified system performance when the operator's job is considered.

Performing Activity and Program Element

This work is performed by the Naval Air Development Center (NADC). Funding is furnished by Program Elements 62757N and 63701N.

Approach and Results

"Modeling," as used here, means using a computer program to simulate a future system and to predict its actions. System inputs—the times, kind, and number of mission events—are fed into the program. The program then computes how these inputs will go through the system, part by part. It is thus able to predict how the system will react to any specific sequence of events.

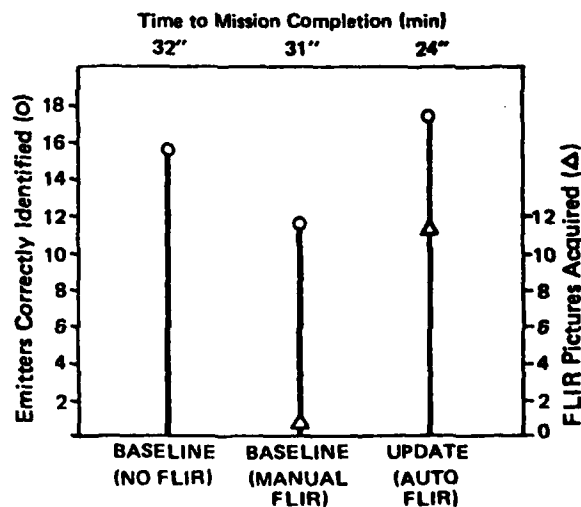
In this research effort a highly sophisticated computer model, the Operator Interface Cost Effectiveness Analysis (OICEA) model, was developed, and has been used to evaluate the performance of systems under varying assumed mission conditions. This model was adopted from the existing NADC Human Operator Simulator (HOS) model, which had been developed to evaluate the operability of systems during early design.

OICEA uses the HOS to answer questions about proposed new systems and alternative system designs.

The OICEA model can simulate the behavior of a proposed system by calculating the interactions between the human operator, the system hardware and software, and the events of an operational mission. The system model can include the effects of operator-related variables such as the locations of displays and controls, operating procedures, decisionmaking, observation, recall, and physical movement, with allowance for individual operator differences. The system model is responsive to differences in mission scenarios. It can be loaded with differing hardware data and run repeatedly to evaluate the operator consequences of differing system configurations. The outcomes are expressed in terms of mission objectives achieved (or not achieved) in units of time.

Utilization/Technology Base Advance

The OICEA system model was developed and has been applied to evaluate alternate mission equipment configurations for the P-3C surveillance aircraft. Two versions of a Forward Looking Infrared (FLIR) sensor capability were compared. One, an interim version that had been implemented in the fleet, was manually controlled. In the fleet it proved unusable, and interfered with other tasks to actually cause a net loss in mission effectiveness. The OICEA model clearly predicted this outcome. An alternative, advanced FLIR installation showed higher performance on all measures and was cheaper to operate (see figure).



Evaluation of Alternative Infrared Sensors for the P-3C:
Summary of System Performance

The OICEA model provides a precise and reliable technique for early prediction of the costs and effectiveness of manned system. It is now being used to evaluate operator functions in both acoustic and non-acoustic sensor systems, and is planned for use in determining which of several possible decision-aiding software systems gives the greatest increase in system performance.

Payoff/Potential

The OICEA method promises substantially improved performance for manned systems in the fleet. It will assure both that new systems are effective when

used by real crewmen and that system updates are designed in the most mission-effective configuration. Automated systems pose the hazard that they may not justify costs, or may actually be counterproductive. OICEA can prevent such costly surprises. In the case of the FLIR sensor system study for the P-3C, OICEA showed that one alternative resulted in less operator disruption in the performance of other intelligence tasks, took less time to perform the mission, and was 25% less costly to operate. Early application of the OICEA technique could have saved several million dollars by preventing the development of inferior hardware. OICEA is potentially applicable to all manned systems.

MAN/COMPUTER "VOICE INTERACTIVE SYSTEMS" TECHNOLOGY

Need

Navy fliers are faced with too many tasks requiring the use of eyes and hands. Excessive workload can have serious adverse effects on mission effectiveness and safety. The workload must be reduced if the performance potential being designed into new systems (and which the operator is now too busy to fully utilize) is to be attained. New designs for airborne systems reduce crewstation crowding but do nothing to reduce workload problems because they still continue to rely solely on visual and motor task performance by the operator. The research discussed here is an effort to supply the operator with an alternate means of communicating with the aircraft system: the spoken word.

Performing Activity and Program Element

The project is being carried out by the Naval Air Development Center under Program Elements 62757N and 63701N, with the assistance of the Naval Training Equipment Center and the Naval Aerospace Medical Research Laboratory.

Approach and Results

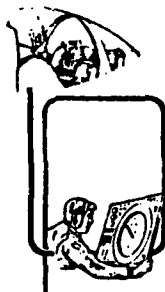
In general, voice systems allow the operator to input data or ask questions about the status of the system using conventional speech, and to receive verbal status advisories or warnings as well. This capability for full "interaction" by voice is called a voice-interactive system (see figure).

PROBLEMS

- EXCESSIVE CONTROL ACTIONS
- SEVERE VISUAL & MOTOR OVERLOADING
- CROWDED CREWSTATIONS

SOLUTION

- USE SPEECH & HEARING CHANNELS FOR DATA INPUTS/OUTPUTS



APPLICATIONS

- MPA
- VSTOL
- GCA TRAINING
- AIC TRAINING
- VTXTS

PAYOFFS

- REDUCED DISPLAY COMPLEXITY
- FEWER CONTROLS/DISPLAYS
- IMPROVED RESPONSE TIMES
- MORE EFFECTIVE TRAINING

PRODUCTS

- DEMONSTRATED VOICE SYSTEM
- AIRBORNE VOICE SYSTEM DESIGN SPECIFICATIONS
- VOICE APPLICATION PAYOFF MATRICES
- VOICE TRAINING REQUIREMENTS

Voice Interactive Systems

for crewstation applications. There is widespread interest in voice systems throughout Department of Defense agencies and NASA. Industry and government symposia have been sponsored to encourage the joint use of voice products, and a government-wide voice technology coordinating group has been established.

Payoff/Potential

Voice systems can reduce workload and enhance the productivity of the operator in a variety of system

applications. Laboratory studies and operator estimates indicate that data can be entered into onboard computers two to three times faster by voice than by manual keyboard when the operator is performing a control (hand) or visual task at the same time. A voice system fully integrated with other weapon subsystems can reduce time to detect and respond to an emergency by 30% to 50%, depending on the operator's involvement with other tasks. Such time savings during critical mission segments could yield dramatic returns in improved mission performance.

TARGET ACQUISITION AND TARGET VISIBILITY

Need

Pilots of fighter and attack aircraft seek ground targets to launch air-to-ground weapons against. Visual acquisition of a target is often difficult, however, and can be greatly hindered by specific conditions of weather, lighting, or terrain. Attack effectiveness falls off sharply under poor visual conditions, and those conditions must be taken into account in planning strike missions. Visibility must be considered in deciding which targets to attack, specifying the number of aircraft, selecting weapons and altitude, and deciding other mission tactics. But current strike manuals provide no guidelines for considering visibility. They address accuracy, warhead effects, and target vulnerability, yet provide no means of assessing the variables that will affect the visibility of the target.

Recognizing this problem, the Chairman of the Joint Technical Coordinating Group on Munitions Effectiveness (JTTCGME) generated a requirement for methods to assess the effects of target visibility. Required was a procedure by which mission planners could estimate the probability that an aircrew would be able to acquire a target visually and successfully launch a weapon under varying conditions of terrain, geographic location, altitude, weather, time of day, and season of the year.

Performing Activity and Program Element

This work was performed by the Naval Weapons Center and by a Triservice Target Acquisition Working Group. Funding was from Program Elements 62763N, 62757N, and from the Joint Technical Coordinating Group on Munitions Effectiveness (JTTCGME).

Approach and Results

Existing data that had been developed over a 30-year period were collected from the Navy, the Army,

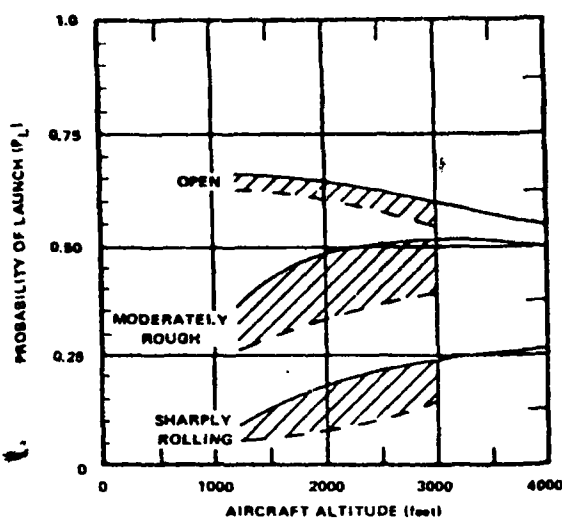
and Air Force, and from British sources. Where no data existed, as for the target-masking effects of terrain, research was performed to produce it. Mathematical formulae were developed which could interpolate for conditions under which existing data were not sufficient and, specifically, to extrapolate for lower altitudes.

The combined results were developed into a series of tables and charts for use in mission planning. They were published in 45 interim reports and finally compiled into a Target Acquisition Manual. The manual includes chapters on flares, sun angle, clear line-of-sight, visibility/ceiling and weapon-launch opportunity. Specific data include:

- Sun elevation and azimuth at any time of day and year, at any earth location.
- Tactics for optimal delivery of illuminating flares during night attacks.
- Probability of clear target line-of-sight for differing terrain and vegetation conditions.
- Probability of visual target acquisition in time to attack, as a function of flight altitude.
- Weather data (visibility and ceiling) characteristic of a number of earth locations.
- Variations in weapon release conditions, to minimize effects of wind and haze.

These data can be compared to estimate the probability of a successful attack against targets of various types, under various mission and environmental conditions. Data are given for using most classes of Navy and Air Force weapons.

The graph which follows, for example, can be used to estimate the probability of a weapons launch as a function of altitude and for three contrasting types of terrain. The graph has been edited to remove classified data.



Weapons Launch Probability Related to Altitude and Terrain

Utilization/Technology Base Advance

In addition to publication in the Manual, results of this program have been disseminated in reports of the JTCGME, and are in use by the Air Force, Army, and Marine Corps. Pertinent data are now in the Navy tactical manuals for the A-7 aircraft, and they will be included in manuals for the A-6. Findings are being used in training at the Navy Weapons School at Lemoore, California.

Payoff/Potential

These methods of analysis will be used by all U.S. armed services in tactical air-to-surface strike mission planning. They will result in more efficient allocation of tactical air resources in combat and aircraft losses will be reduced. By conservative estimates, use of the target acquisition manual will increase attack effectiveness by a factor of two, providing sharply improved use of aircraft and munitions resources.

CREWSTATION ASSESSMENT OF REACH (CAR) MODEL

Need

The crewstations of an aircraft must be usable by crewmembers who vary widely in physical size. If a significant number of pilots cannot reach the critical controls, accidents and injuries will increase. Between 15 and 20 aircraft mishaps per year have been attributed to difficulties in reach, at a cost of 20-30 million dollars in damage. The problem has become serious enough that the Chief of Naval Operations recently asked that aviators be matched with specific aircraft according to how well they "fit" the physical dimensions of cockpits and controls. While this approach is effective in reducing accidents, it limits the use of the trained aircrew population and wastes valuable training and retraining time. Pilot/cockpit size mismatches can usually be solved by early engineering design changes. But to do so requires that cockpit geometry mismatches be detected while the aircraft is still on the drawing board. To that end, the Navy needs a method of analysis that can compare and quantify planned cockpit geometry against the aircrew population at this early design stage.

Performing Activity and Program Element

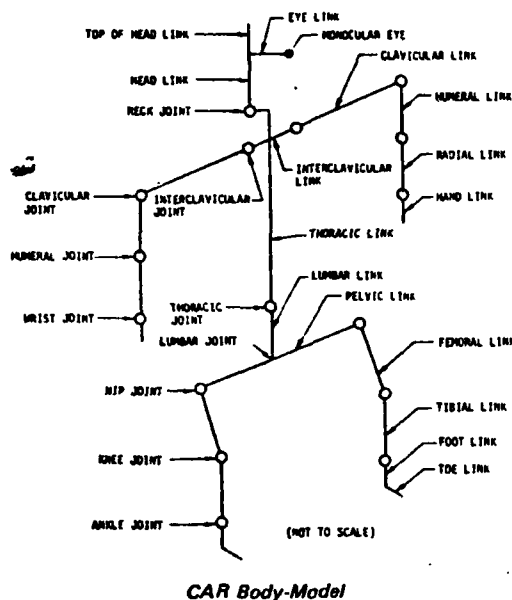
This work is performed by the Naval Air Development Center under Program Elements 62757N and 63701N.

Approach and Results

To meet the need for a method of comparison, NADC developed the Crewstation Assessment of Reach (CAR) model. The CAR model is based on extensive prior research in industry and government. This work has resulted in sophisticated cockpit geometry models which can compare the physical dimensions of a specific operator against the dimensions of a proposed crewstation. The CAR model uses a condensed version of those earlier models to evaluate a cockpit design against a statistical sample representing the entire operator population. Thus, CAR is able to estimate the percentage of available aircrewmembers who can operate a proposed design and the percentage who will have difficulty in performing any specific control action.

CAR is applied at the earliest possible stage of design, using the initial drawings as an input. The model examines hand and leg control positions, head/canopy clearance, and seat movement required to achieve over-the-nose vision. Where reach or clearance problems are detected, CAR identifies the controls involved. Because the computer program is "interactive," the researchers can immediately evaluate alternative designs. A large number of alternatives can be explored with a minimum of time and cost, and acceptable solutions can be identified promptly.

CAR uses a mathematical model of the human skeleton, consisting of the major body segments ("links") and the joints which connect those links, with all their lengths, limits of movement, and variations in dimension within the operator population (see figure). It can quickly calculate how the skeletal model must move to perform any specific action, under various conditions of harness restraint or requirement for hand action (e.g., grasp, touch, manipulate).



Utilization/Technology Base Advance

CAR has been used in the design of three aircraft: the Light Airborne Multi-Purpose System (LAMPS) MK-III (SH-3), the F-18, and the AV-8B. For LAMPS and the F-18, changes were recommended and were used in further development. For the AV-8B, studies are still in progress to correct some identified problems.

Applied to the F-18 preliminary design, CAR revealed that only 20% of the aviator population would be able to use all critical controls. The seat, stick, and emergency controls were therefore relocated, using CAR recommendations, to accommodate nearly 100% of aviators. The engineering changes that were required included major modifications of the aircraft structure.

CAR has been adopted for use elsewhere in the government and in industry. Within the government, it has been modified by NASA for Space Shuttle design. In industry, it has been used in-house by McDonnell-Douglas, Northrup, Sikorsky, the Clark Equipment Company, and IBM.

Payoff/Potential

Earlier methods of analyzing cockpit geometry required laborious manual procedures, or else computer models not suitable for use in early stages of design. The results were often expensive, late, imprecise, and hard to convey to design engineers. At worst, problems remained undetected until the aircraft were in service, and then often surfaced as accident data. CAR improves the accuracy of analysis while reducing the time required from more than two weeks to less than a day, with a 90% decrease in cost. CAR can be applied earlier in the design cycle than ever before, and used interactively to find engineering answers and test them ahead of time. It will produce aircraft which are more mission-effective because they are better fitted to the aircrew.

For example, when used to guide design of the F-18, CAR made it possible to correct on paper design deficiencies that would have cost millions to change if not detected until construction began. Savings through avoiding lost training time for pilots who could not have safely used the initial design are estimated at 10 to 40 million dollars per year.

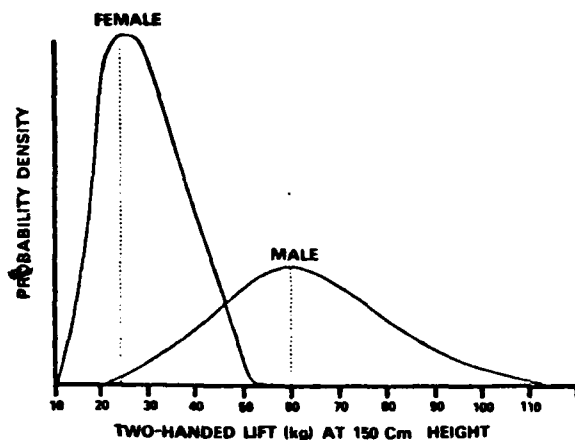
OPERATOR/MAINTAINER EQUIPMENT HANDLING EVALUATION

Need

The size and location of equipment components in modern systems has been mainly a function of space availability. Very little attention is given, in designing equipment, to the accessibility of components or to the physical strength a maintainer needs to remove, carry, and replace the components. Consequently, injuries occur as a result of handling overweight, unbalanced components. More significantly, there are

many maintenance tasks that can be performed by only the strongest members of the operator/maintainer population (see graph). Available design standards are incomplete. They are based only on the human capabilities seen in *static* strength situations, and they do not address the female maintainer population. The operational impact of these deficiencies is lower maintainer productivity through the poor use of available maintenance manpower. More comprehensive

equipment-handling standards and design criteria are required. Computer models can then be used to predict the percentage of maintainers who can perform the manual equipment-handling tasks required by a particular design.



Male-Female Populations: Strength

Performing Activity and Program Element

The research is being performed by the Pacific Missile Test Center for the Naval Air Development Center, under Program Element 62757N and 63701N.

Approach and Results

Designing equipment for improved maintainer handling calls for a dual approach. First, to provide

guidelines for system designers, available data on dynamic handling tasks are being combined with new research results to give improved design criteria for incorporation into human factors military standards. Such tasks as lifting, lowering, pushing, pulling, and carrying all require individual treatment in the development of standards. Second, data for standards also serve as the basis for computer models of equipment handling tasks. These models will estimate the percentage of a specified population that can accomplish a particular handling task. They will consist of a series of submodels (for lifting, lowering, etc.) integrated into a single interactive computer routine. Efforts thus far have focused on the prediction of equipment lifting capability.

Utilization/Technology Base Advance

Preliminary strength data emerging from this research have been used at NADC to evaluate Light Airborne Multi-Purpose System (LAMPS) and F-18 handling tasks. Several serious component weight and location problems have been identified and resolved.

Payoff/Potential

Initial results and experience with earlier design models indicate that the proportion of maintenance personnel who can perform *all* tasks will increase by 100% to 300%. Simply put, 2 or 3 times as many maintainers will be able to perform all the tasks in a new system without encountering problems of physical size and strength. Eventually this will improve the effectiveness with which the maintenance personnel pool is utilized, especially the women.

AIDS FOR HUMAN DECISIONMAKING

Need

At the heart of the Navy's mission is human decisionmaking. We recognize that human decisionmaking is imperfect, being subject to error, inconsistency, and bias. Especially vulnerable are decisions which must be made in unpredictable circumstances. Typically, these require the assessment of probable costs and benefits. They may involve risk, and may be made on the basis of incomplete information. Such decisions will not soon be automated, yet they are often critical to the success or failure of programs.

Therefore, in 1971 the Office of Naval Research (ONR) began a program of research to understand and to aid human decisionmaking behavior. In 1972, the Defense Advanced Research Project (DARPA)

began a related program to develop decisionmaking aids, and the two programs have been coordinated since then.

Performing Activity and Program Elements

This program is conducted by ONR with the support of DARPA. Funding is provided by Program Elements 61153N, 61101E, and 62709E.

Approach and Results

Psychological experiments were used to identify types of decision error and the conditions under which they are likely to occur. Preliminary results indicated that people show bias in making predictions, and are inconsistent in their apparent preference for outcomes.

Among other things, it was found that people are especially poor at judging the likelihood of events that have a low probability to begin with. In assessing situations, they tend to make a quick hypothesis and then stick to that hypothesis even in the face of conflicting evidence. When given the correct answer, they tend to feel that they "knew it all along." People's preferences for alternate outcomes are strongly influenced by the wording used (for instance, "lives lost" versus "lives saved"), even though the outcomes are actually identical.

Experimental findings were consolidated into theories explaining how human judgment fails. These theories were used, in turn, to develop techniques to aid specific kinds of judgment. It was also recognized that judgment can be aided by checklists and procedures. More powerful aids can be based on statistical decision theory, or on computer models of events which provide the opportunity to try out alternatives and see their results. For repetitive decisions, adaptive models can "learn" the rules used by good decision-makers and use them to guide others.

Utilization/Technology Base Advance

Research results have been widely distributed as technical reports and in briefings to potential users, as well as in reports in the scientific press. In 1978, at least 16 journal articles or book chapters deriving from this program were published.

Specific decision-aiding techniques were developed and tested in the Navy, Army, and DOD. For instance, Headquarters, European Command used a decision aid to assist in tactical contingency planning; and a computer model was used to analyze factors affecting the positioning of the Mediterranean Fleet in the event of a need to evacuate civilians. Planners

were able to explore various options and examine their outcomes. Other decision aid utilization has included:

- Resource allocation during the Program Objectives Memorandum (POM) cycle, tested in the Marine Corps.
- Decisions by a Tactical Air Coordinator during antisubmarine operations, tested by the Naval Air Development Center.
- Evaluating human factors considerations in the F-18 aircraft, tested by the Pacific Missile Test Center.
- Evaluating proposals for an electronics warfare suite, tested by Naval Electronics Systems Command.
- Evaluating battlefield tactics in a tactical operations center, tested by the Army Research Institute.
- Decisions in the World Wide Military Command and Control System, to be evaluated by the Defense Communications Agency.

As a result of this research, the Naval Materiel Command has sponsored an exploratory development program to find points throughout the Navy and Marine Corps where decision-aiding techniques can be applied in command and control systems. Similarly, the Chief of Naval Operations has an advanced development program to develop decision aids for use at the Task Force Command level.

Payoff/Potential

Aids to human decisionmaking can increase the effectiveness and reliability of military planning, command, and control. They apply equally to all services, and can substantially reduce the hazard of misjudgment in military decisions.

VISIBILITY REQUIREMENTS FOR UNDERWATER INFORMATION DISPLAYS

Need

For years, Navy divers have conducted their underwater operations without being able to see or communicate very well. They have had to work by feel in the dark, to accomplish a limited range of team tasks according to well-rehearsed procedures, and to convey simple messages using touch and hand signals. The diver's information aids had been limited, until recently, to a depth gauge, compass, and watch.

Recent advances in diving technology have created demanding new requirements for equipment-to-diver

communication. The free-flooding manned submersible, for instance, includes a display console with information displays critical to the functions of navigation, surveillance, maneuvering, and life support. The mixed-gas underwater breathing apparatus includes displays of the status of the gas mixture and readout from a decompression computer. Information transfer has thus gained new importance.

However, most existing display designs are not suitable for underwater viewing through a faceplate. A research program was therefore begun in 1974 on underwater vision related to display design.

Performing Activity and Program Elements

This project was performed by the Office of Naval Research. The Office of the Chief of Naval Operations contributed important operational guidance and provided liaison with operational commands. Funding was from Program Element 61153N, with additional support from the Naval Sea Systems Command under Program Element 63722N.

Approach and Results

The working environments of Navy divers and submersible operators are mainly in-shore harbors, rivers and bays, and near-shore coastal oceanic waters. Each has its own turbidity, defined by sizes and concentrations of suspended particles, which scatter natural light and determine the amount and color of light energy present at operating depths. Turbidity also affects transmission of light from a display by reducing brightness and selectively scattering light energy.

The research program was directed at both display requirements and basic experiments on visual performance under water. The research team was comprised of specialists in the areas of vision, human factors, and oceanography.

Analysis of the visual tasks of divers and submersible operators showed that the most common tasks were reading of numbers and signal detection, so these were given priority during the experimental work. Turbidity of harbor and oceanic waters was simulated in the laboratory.

The results of the visual performance experiments showed that the strongest factor in the legibility of a display in turbid waters is its brightness. The size of the display and its color are less important, although it was found that greens are more legible than reds. Also, variations in turbidity of ocean water had little effect on the legibility of displays, whereas variations in harbor turbidity had a major effect.

The scientific and technical aspects of the program were coordinated with the Naval Submarine Medical Research Laboratory and the Naval Sea Systems Command. Logistic support was provided by the Naval Special Warfare Group-Atlantic, and officers and enlisted personnel from Underwater Demolition Teams participated in the laboratory experiments.

Utilization/Technology Base Advance

Experiments are continuing to fill in the gaps in our understanding of underwater visual performance

by studying display characteristics in ambient high luminance, using light-adapted observers (the experiments reported here were done in the dark). Such conditions are also commonly found, and bring into play a different set of light-energy characteristics and visual/perceptual processes.

Aside from providing the basis for engineering guidelines in designing displays, one of the experimental innovations of this project will make future studies of underwater readout visibility easier to carry out. Specifically, a way to simulate natural turbidity conditions by using inorganic particles all of the same known diameter was devised. Particle sizes and concentrations were chosen for each laboratory environment to approximate the median sizes and concentrations found naturally in that kind of environment. Tests showed a close compatibility between the simulated and natural environments for the purposes of visibility studies.

Results of this research have been widely distributed in the form of technical reports and briefings to potential users in both the research and fleet operational communities. Representative commands and Navy laboratories include: the Naval Sea Systems Command, the Special Warfare Group-Atlantic, the Naval Medical R&D Command, the Naval Medical Submarine Research Laboratory, the Naval Coastal Systems Laboratory, and the Naval Ocean Systems Center.

Payoff/Potential

These research findings provide the background for the human engineering that will be designed into displays to be used in the ambient undersea environment, such as the instrumentation in free-flooding manned submersibles, the hand-held and wrist-mounted display components of diver support systems, and displays mounted on underwater structures. Display coding and photometric deficiencies in current systems can be corrected with firm human engineering guidelines, and better designs can be drawn for new systems used by Navy salvage divers, explosive ordnance disposal (EOD), underwater demolition (UDT), and sea-air-land teams (SEAL). Transfer of information, both system-to-diver and diver-to-diver, will be much improved under these experimentally derived guidelines, so that underwater operations may be carried out more rapidly and efficiently than is now possible.

NAVY TECHNICAL INFORMATION PRESENTATION SYSTEM (NTIPS)

Need

Serious deficiencies exist in Technical Information (TI) accompanying hardware systems in the Fleet. Consequently, material readiness is reduced through inefficient manpower utilization and poor maintenance, training, logistic support, and operations. Typical deficiencies are:

- Increasing complexity and volume of TI coupled with decreasing reading and comprehension ability of new Navy personnel, which has created a readability gap that tends to decrease motivation and impair efficiency.
- Delays in providing initial documentation and in updating documents to correct errors and reflect configuration changes.
- Inconsistencies between technical documentation for training and technical documentation for maintenance.
- An excessive number of errors and other inadequacies in TI.
- Escalating costs of developing and distributing TI.

As a result of these deficiencies, dissatisfaction with and underuse of technical information have been increasing among Fleet operating, maintenance, logistic support, and training personnel.

For example, a December 1977 message concerning material readiness of Fleet ships from Commander Seventh Fleet to Commander in Chief, U.S. Pacific Fleet, stated that "faulty or absent documentation was mentioned by everyone as a significant detriment."

Another December 1977 message on the same subject from Commander Amphibious Group One to Commander Naval Surface Force, U.S. Pacific Fleet stated, "Technical documentation continues to be a major failing of the system. Unfortunately it permeates the entire maintenance effort from the organizational to depot level." The recommendation from the Commander Amphibious Group One was to "continue to press the Systems Commands for better support in such areas as source documentation for Personnel Qualification Standards, Repair Manuals, and Prints."

To correct such problems as these, the Chief of Naval Operations requested an R&D effort to develop a comprehensive Navy Technical Information Presentation System (NTIPS). When completed and implemented, this will be a Navy-wide system for the generation, distribution, and control of TI, for use in system operation, maintenance, training, and logistic support.

Performing Activity and Program Elements

The David W. Taylor Naval Ship Research and Development Center is technically responsible for the development of NTIPS. Supporting research is being

provided by the Training Analysis and Evaluation Group and the Navy Personnel Research and Development Center. Planning, programming, and budgeting for the implementation and continuing utilization of this system, once it is designed, are being carried out by the Deputy Chief of Naval Operations (Logistics), the Deputy Chief of Naval Material (Logistics), and the NTIP Program Office. Funding comes from Program Element Numbers 62757N and 63727N. This project was reported in the first Annual Report on the Utilization of People-Related RDT&E, published in May 1978.

Approach and Results

A systems approach is being taken to develop a single process for the complete control of hardware-related TI. The needs of all user communities are being considered concurrently. Human factors engineering technology and other supporting technologies such as logistics, micrographics, automatic data processing, and publishing are being applied and developed. The development program is being carried out in three phases:

- I. System and Feasibility Tradeoff Analysis
- II. Critical Element Testing and Detailed NTIP System Design
- III. Prototype Test and Implementation Recommendations.

Phase I, which has been completed, achieved four major accomplishments. First, actual problems experienced with TI in the Fleet, the various Systems Commands, and the Training Community were identified. Second, the current state-of-the-art in TI generation, distribution, and control was assessed, together with current TI procedures in the Department of Defense and elsewhere. Third, evolving human factors and supporting technologies in TI were also assessed and synthesized. A concept for effecting a user-data match for TI has been defined. This concept involves the application of human engineering principles to the definition of *what* information is required by various classes of users and *how* best to present it. The key is a methodology to achieve an effective balance among the various combinations of personnel characteristics, job tasks, work-environment conditions, training considerations, maintenance philosophy, and appropriate TI formats and media. Fourth, a preliminary NTIP System concept was developed.

During FY 78, a review and critique of the preliminary NTIP system concept was obtained from the various Navy Systems Commands and the Training Community. Modifications and supplemental research were carried out in order to provide the basis for designing an effective and acceptable system for all users,

including the Fleet and Squadrons, the Intermediate and Depot Maintenance Facilities, the Naval Material Command and Program Managers, and the Training Community. This research resulted in the:

- Definition of the interface between the Integrated Logistic Support process and NTIPS, which will reduce costs and errors by working from a common data base.
- Definition of the NTIPS interface with the Training Community, which will insure that the TI is suitable for training and that the needs of the Training Community are met.
- Identification and test of improved formats for presenting TI to pilots and crew members, resulting in an increase in comprehension and recall of safe ejection procedures of as much as 47%.
- Conclusion that a fully automated, digitally based NTIP System capable of providing and controlling variable-medium output (i.e., paper, microforms, electronic displays) is feasible.
- Identification of the implications of an all-digital system which will (1) permit matching the TI to varying experience levels; (2) be amenable to proceduralized job aids; (3) make TI update and configuration management easy; and (4) be capable of covert data collection on maintenance efficiency.
- Development of the concept of modular specifications, in which a computer will be used to select and compile individual requirements statements for each kind of TI as specified by the NTIPS user-data match methodology.
- Development of a computer-authoring concept in which the computer is preprogrammed to write course material. A computer-authored training package for Morse Code resulted in an increase of 26% in comprehension by lower-aptitude Signalmen.
- Definition of an automated publishing system for the Training Community that will result in a \$700,000 savings annually.

Utilization/Technology Base Advance

This research has been incorporated into the preliminary system concept. The concept is now adequate for initiating in FY 79 the detailed system design. Five short-term TI improvements resulting from this research have been provided to the Systems Commands and Training Community, which are proceeding to implement them. First, as a result of the improved TI format research, an instruction is being developed for use by NAVAIR in the writing of emergency procedures found in pilots' manuals. Second, NAVSEA is

currently planning to implement the modular specifications concept. Third, a quality assurance specification based on the new approach described is being developed for NAVAIR use. Fourth, the Training Community has adopted the computer authoring programs to write course material on Morse Code for signalmen, and is currently developing 23 lessons for aerographer's mates using the system to teach meteorological symbols. Finally, the Chief of Naval Education and Training has approved and budgeted for a computer-aided publishing system at four major Instruction Systems Development Sites.

Payoff/Potential

When implemented, NTIPS will assist the Fleet in several ways. From the perspective of operators and maintenance technicians, it will represent an improvement in:

- Technical Information quality and consistency — The user-data match process will help insure that the new TI will be written at a level to match the ability of the user and will be presented in a format and medium suited to his job tasks and working environment.
- Accuracy of the TI — Improved quality-assurance procedures and speedier correction of errors and resolution of configuration mismatches between hardware and the TI will result from a better system for configuration control and remedial action and update procedures.
- Homogeneity of the basic technical content presented to the user—first, in his service school ashore, later, in his shipboard training, and, finally, in his working assignment (operating or maintenance). NTIPS will provide coordinated TI for training, operating, maintenance, and logistic support communities.
- Efficiency of TI Preparation and Control — More efficient, standardized methods of generation, replication, distribution, feedback, and update are inherent in NTIPS. These will reduce costs and procurement and delivery times.
- Opportunity to apply cost savings resulting from NTIPS to improve Fleet readiness in other areas — The Navy currently maintains a \$5 billion inventory in TI and spends hundreds of millions of dollars on TI annually. Savings of no more than 10% could represent \$50-\$100 million annually in new TI alone. These savings could be diverted to other areas where funds are badly needed. In addition, time saved aboard ship by eliminating inaccurate or inefficient TI can represent a significant contribution to readiness.

EDUCATION AND TRAINING

DoD defines this area of People-Related RDT&E as follows:

"Development of educational/training methods and media for managing, designing and evaluating new generation instructional systems for military applications."

The Navy training establishment faces major challenges in trying to maintain personnel readiness to meet operational demands while it is faced with economic restrictions, manpower competition, and the increasing sophistication of weapons. New technology is needed to refine training standards to match job requirements, to reduce training costs, to provide training to fleet personnel without removing them from ships, and to vastly improve the Navy's entire system of planning and conducting training.

Projects in this category include:

- **Testing Out a Shipboard Computer-Managed Instructional System**
- **A Computer-Assisted Individual Study Program**
- **Development of a Tactical Action Training Environment (TATE)**
- **Automated Testing of Performance in Computer-Managed Instruction**
- **USMC Rotary-Wing Air Navigation Training**
- **Desktop Computer Used to Enhance Submarine Tactical Training**
- **Instructional Quality Inventory**
- **Computer-Based Training Systems**
- **Evaluating Methods for Equal Employment Opportunity Training**
- **Recruit Training Preview Reduces Attrition**
- **Establishing Liaison With the Nation's Schools**

TESTING OUT A SHIPBOARD COMPUTER-MANAGED INSTRUCTION SYSTEM

Need

The growing sophistication of shipboard weapon and support systems, with their complex maintenance requirements, has added to the Navy's training and administrative workload. At the same time, other factors have combined to place more strain on an already heavily burdened shipboard training management system:

- Introduction of the Personnel Qualification Standard (PQS) System into the fleet means that more operational training must be done afloat.
- Fiscal constraints have made onshore classroom training less readily available.
- Reduced fleet manning means that fewer personnel are available for training and administrative details.
- A shortage of middle-grade petty officers has further aggravated the training and paperwork burden afloat.

Performing Activity and Program Element

This project was funded under Program Element 63720N. The performing activity was the Navy Personnel Research and Development Center, San Diego.

Approach and Results

To test the workability of a computer-managed instruction and training system aboard ship, a minicomputer-supported Automated Shipboard Instruction and Management System (ASIMS) was implemented and evaluated aboard a guided missile cruiser. The ASIMS consisted of two integrated programs—one for individualized Computer Integrated Instruction (CII) and the other a Shipboard Training Administrative System (STAS) to provide automated file management capability. It was found that:

- End-of-training mean test scores for CII graduates were significantly higher than scores obtained by three groups being taught with traditional shipboard methods.

- CII student throughput, as measured by course modules completed per month, increased with increases in automated command and administrative controls of student progress.
- Nineteen STAS management applications in personnel and training administration, operations, material maintenance management, and supply were developed and implemented. Each STAS application met a specific shipboard management requirement and saved administrative time and labor over existing manual methods.
- Student and supervisor attitudes toward the use and value of ASIMS were good.
- ASIMS minicomputer system hardware, which used "off-the-shelf" commercial equipment, had an overall system reliability factor of .928 (approximately 7% downtime) aboard ship.

Utilization/Technology Base Advance

This project demonstrated that a Computer Managed Instruction (CMI) system using individualized instructional techniques can be effectively and efficiently used aboard a Navy ship. Actual utilization was carried out on board the Guided Missile Cruiser USS Gridley, CG-21. The research also indicated that a commercial minicomputer system can operate reliably at sea to provide these capabilities.

Payoff/Potential

Use of CMI aboard ship accords with the current efforts by CNO to place minicomputers on all warships during the 1980s, under the Shipboard Non-Tactical ADP Program (SNAP). A shipboard CMI and an automated training management system can provide cost savings by assisting in the delivery and management of training aboard ship.

A COMPUTER-ASSISTED INDIVIDUAL STUDY PROGRAM

Need

The Navy operates the largest computer-managed instructional system in the world. The people who operate this system have suggested the need for im-

proved self-study techniques. If learning and retention of instructional material could be improved in such programs, time in class could be cut, cost of training reduced, and levels of competency increased.

Performing Activity and Program Elements

The project was performed by the Navy Personnel Research and Development Center with funds provided under Program Elements 62757N and 63720N. The research was initiated by the Office of Naval Research, under Program Element 61153N.

Approach and Results

This exploratory development project examined the feasibility of applying theories about human learning to actual Navy classroom settings. A study management procedure, the Computer-Assisted Instructional Management System (CAISMS), was developed, tested, and evaluated in terms of its effect on test performance and course completion times. The system is based on the "depth of processing" model, which suggests that the more thoroughly and actively instructional materials are processed (repeated, paraphrased, and transformed), the more will be learned and remembered. The study management plan is designed to require a high degree of such processing by the student, using frequent question-answering to promote the processing.

CAISMS was experimentally evaluated in an undergraduate university course setting. Students trained on the CAISMS scored higher in the course than did students receiving the same material via traditional lecture presentation.

Utilization/Technology Base Advance

The CAISMS program was applied by NPRDC in the Interior Communications Electrician (IC) class A

School. Use of the CAISMS test procedures resulted in better performance on achievement tests by those students than by trainees receiving lectures. Next, CAISMS was tested in the self-paced final week of the School. CAISMS trainees completed the week's work one day sooner than trainees under the instructor-managed version of the course. The added time allowed more "hands-on" laboratory sessions to be scheduled.

The successful IC School projects represent an application of CAISMS to a class A School with substantial technical content and a large annual student load. Current implementation efforts at Fleet Antisubmarine Warfare Training Center are examining the utility of CAISMS for individualizing class C Schools, where there are higher proportions of laboratory exercises and smaller student loads.

Payoff/Potential

The individualization of Navy class A Schools complicates the scheduling of follow-on class C Schools because no precise graduation date is available. Many man-days are lost in the "Awaiting Instruction" status. Individualization of the follow-on School, with flexible start dates, could eliminate this loss.

Since group-paced instruction is usually paced for the slow learner, the implementation of CAISMS would provide further savings in training costs by allowing most trainees to complete the course in less than the time allotted for the group. Also, experienced Fleet returnees would complete training more quickly, thus reducing both the cost of training and the negative impact on the ship's manning created by their absence.

DEVELOPMENT OF A TACTICAL ACTION TRAINING ENVIRONMENT (TATE)

Need

To maintain operational readiness, officers and enlisted personnel must be trained in complex skills. In many cases, such as tactical decisionmaking, training practice is severely limited by the expense of individual instruction, the scarcity of practice opportunities, or the lack of appropriate simulation facilities. Rapidly decreasing computer hardware costs, advanced programming techniques, and improving models of thought and memory now provide an opportunity to expand Navy training capabilities in these areas.

Performing Activity and Program Elements

This project was performed by the Navy Personnel Research and Development Center under Program Elements 62757N and 63720N.

Approach and Results

An advanced exploratory development effort has been undertaken to investigate the applicability of improved computer technology to problem areas in Navy training programs. The objective is to develop

prototype computer-based training systems targeted to particular Navy skills (in this case, Tactical Action Officer-TAO), assess costs, and evaluate the system operationally.

The design concept combines several computer-based instruction systems, including programs for:

- generating exercise situations,
- providing interactive tactical opposition,
- assisting the memorization of tactical parameters,
- coaching the student in situation analysis, and
- monitoring the development of tactical decisionmaking skills.

To construct a complete training system based on this concept would go beyond the bounds of the exploratory effort, so the investigators are building and evaluating prototypes for some of its components—particularly those that can be used “stand-alone,” such as tactical simulation, tactical opposition simulation, and memorization assistance. Out of these prototype systems, substantial design specifications for the full-scale Tactical Action Training Environment (TATE) have been developed.

Utilization/Technology Base Advance

There are now about 600 trainees per year in the TAO training programs. This effort has broken new ground in identifying simulation requirements for the TAO role. The knowledge gained is already being put

to use in simulator programs under way at the Naval Ocean Systems Center and at the TAO schools.

The memorization assistance system that has emerged from this study is notable in its use of small, widely available microcomputers; installation is therefore quick and inexpensive. In addition, the applicability of the system is being widened to encompass many other military training situations. Memorization assistance systems will soon be installed at Fleet Combat Training Center Pacific, where they will also provide the basis for later work on situation analysis tutoring.

This effort is advancing our understanding of how to apply computer-based training techniques to specific Navy training weaknesses.

Payoff/Potential

With the full-scale TATE, a substantial tactical drill and practice capability could be provided wherever it is needed—even aboard ship. Cost estimates compare favorably with those for simulated flight training. This is remarkably inexpensive since there would be no increased requirement for instructors. At this cost, trainee Tactical Action Officers would receive about 20 times more tactical situation analysis and decision-making practice than they do now. Additionally, techniques developed in this study for building simulator components will be of value in the construction of a war gaming simulator for the Naval War College. Finally, an improvement in Navy operational readiness should result.

AUTOMATED TESTING OF PERFORMANCE IN COMPUTER-MANAGED INSTRUCTION

Need

The Navy operates a large-scale computer-managed instruction (CMI) system that handles more than 9,000 students daily. Its objective is to train students in the shortest possible period of time to specific performance objectives. One of several problems identified by an NPRDC analysis of the system concerned the need for automating skill performance testing for certain CMI courses. Automated performance testing (APT) could reduce training time, thereby saving training resources. This need for APT was one of six high-priority problem areas singled out for R&D by the Chief of Naval Technical Training and the Chief of Naval Education and Training.

Performing Activity and Program Element

The APT program was developed at the Navy

Personnel Research and Development Center. Funding was provided under Program Element 63720N.

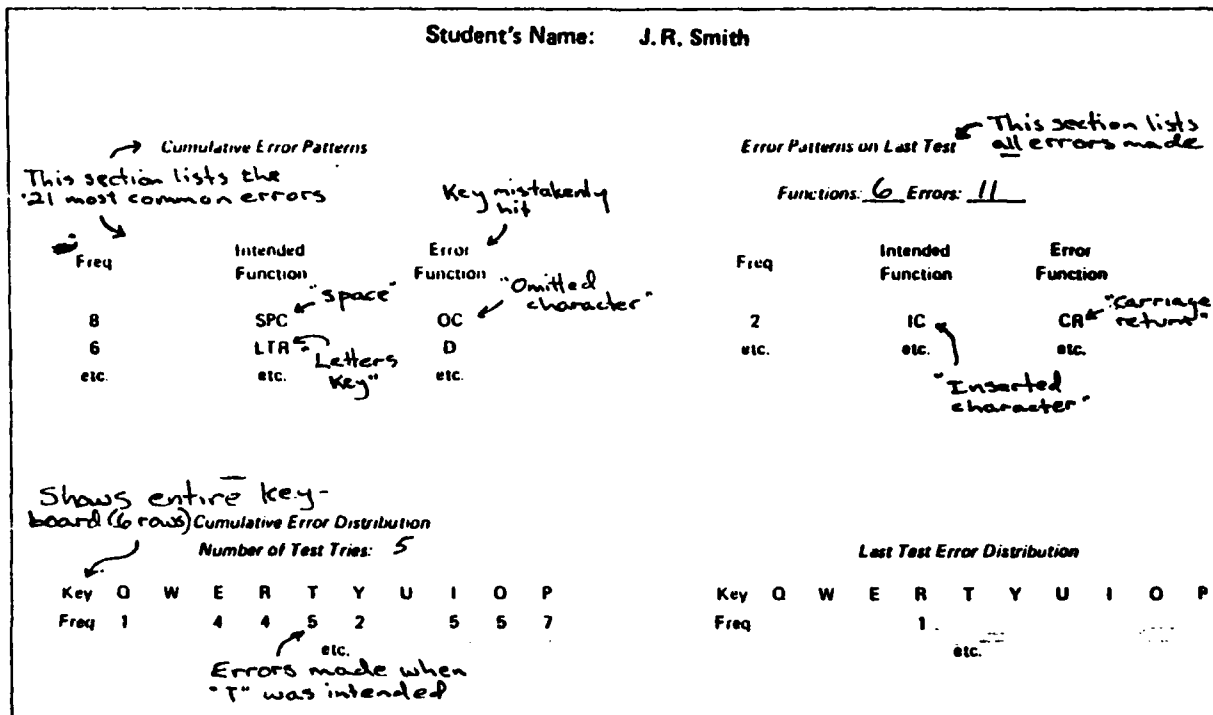
Approach and Results

The need for APT was originally observed in the teletypewriter (TTY) portion of the Radioman (RM) “A” School. When the RM course was implemented on the CMI system, it was found that manual TTY testing was causing delays in training progress; students had to wait a long time between testing and grading. There was also no accurate means of either scoring the tests or keeping records of previous test errors with the manual method.

The APT computer program that was developed times and scores TTY tests automatically, while improving skill performance acquisition through more

effective practice and remediation. An integral part of the automated system is a computer-generated error distribution report (EDR) which allows students to identify their errors in operating the TTY the day after taking the test. A reconstructed partial EDR is shown below. In an experimental comparison with a control

group who did not receive the report, students who did receive the EDRs learned faster and more effectively. They reached the highest level of performance an average of 20.75 hours sooner than those not supplied with this feedback (a saving of almost three days of instruction).



Partial Error Distribution Report (EDR) for Teletypewriter Keyboard

Utilization/Technology Base Advance

Through consultation with the RM school, the Instructional Program Development Center, and NPRDC, procedures for the most effective use of the EDRs were developed. These included guidelines for when and how to distribute the reports and how to use them to direct remedial exercises. The RM school is currently following these guidelines, and the instructors have indicated their satisfaction with them.

The programs developed in this effort represent a significant advancement in instructional technology used in automated performance testing.

An additional benefit of the EDRs was a drop in attrition. While the dropout rate from the teletypewriting portion of the course was 25% for the control group, students receiving daily EDRs had only a 10% attrition rate. The value of the reports was further confirmed by strongly positive student responses to questionnaires about their reaction to the new system.

The APT technology has been shown to give substantial savings through reduced training time

and attrition, and can now be applied to performance skills involved in other CMI courses.

Payoff/Potential

One of the benefits of the APT program is better trainee morale. Students are able to use the computer to learn faster and to verify the improvement in their performance. Other benefits are cost-related. If the nearly three-day reduction per student in teletypewriter instructional time is projected over the entire RM school for a year, the potential annual saving is \$773,000. The reduction in attrition from 25% to 10% could account for the retention of 465 students who would otherwise not complete the course. Since records show that the average time in the course before leaving is 46 days, the potential yearly saving from this source alone is \$1,800,000. The potential for savings in training costs is far higher if APT techniques can be successfully implemented in other schools on the Navy CMI system.

USMC ROTARY WING AIR NAVIGATION TRAINING

Need

Rotary Wing aircrews are facing an increasingly sophisticated anti-aircraft capability in forward areas. This threat has made flight at Vietnam-era mid-altitudes too dangerous. Aircrews must now be prepared to conduct missions at or below treetop level—which is referred to as Terrain Flight. Navigation problems are made more difficult at this altitude by the pilots' oblique perspective of the ground and by the lack of electronic navigation aids for use at the low altitudes of terrain flight.

Performing Activities and Program Elements

This study and associated development were conducted by the Navy Personnel Research and Development Center, and supported by the Marine Air Weapons Training Squadron 1, Marine Corps Air Station (MCAS) Yuma. Funding was provided under Program Element 62757N.

Approach and Results

The objective of the study was to determine how best to develop USMC navigation training to meet the new operational requirement. A Map Interpretation Terrain Analysis program developed for Army aviators was experimentally evaluated to see how well it could be applied to USMC terrain flight requirements. The program was conducted on-site at MCAS Yuma in the context of a Weapons Tactics Instruction Training Course where terrain flight was in the syllabus. Senior Marine Corps instructors acted as subject-matter experts. Students with a minimum of 1000 hours flight time were used as subjects. The subject-matter experts

evaluated the effectiveness of the course by the performance of the students in both academic tests and flight trials.

The Army course was found to be applicable to Marine Corps terrain flight navigation requirements, but it needed extensive modification to become fully effective for training. NPRDC made those modifications and the program was then re-evaluated. Flight trials conducted at MCAS(H) Futema, Okinawa, demonstrated a significant improvement in the navigational performance of the trained aviators compared with the control group of similarly qualified fliers. The course increased checkpoint acquisition performance from 27% to 67% and decreased median error from 320 meters to 100 meters. Time for mission completion was also reduced.

Utilization/Technology Base Advance

The modified Map Interpretation-Terrain Analysis program is now a 14-hour element of the Weapons Tactics Instructor Terrain Flight syllabus. The Marine Corps is now in the process of equipping all Marine Air Groups with this training program.

Payoff/Potential

Marine Corps subject-matter experts and flight instructors estimate that 4 hours per student of the rotary-wing flight time formerly spent on terrain flight orientation is now utilized for more advanced tactical flight training. The successful modification and adaptation of an existing Army program gave considerable cost savings as well.

DESKTOP COMPUTER USED TO ENHANCE SUBMARINE TACTICAL TRAINING

Need

Naval submarine training facilities have expressed a need for reliable, objective performance measurement of submarine fire control parties while they are operating the Advanced Submarine Attack Trainer, the 21A40. Current evaluation of training is done primarily by experienced officers, who judge the performance of the approach officer and the fire control party by the accuracy of their target motion analysis and by weapon hit or miss. What is lacking is a means of providing objective feedback, with some qualitative performance

measure. Such a technique would increase the effectiveness of training and allow some progress toward standardizing training evaluations.

The aims of the effort described here were to design such a performance-evaluation device, to install it within the Advanced Submarine Attack Trainer, and to explore its usefulness.

Performing Activity and Program Elements

The project was carried out at NPRDC, under Program Elements 62763N and 63720N.

Approach and Results

It was decided that the performance-evaluation device would use real-time information gathered from the 21A40 trainer while submarine tactical teams were undergoing training. The device would operate independently of the main tactical computer and not disrupt the trainer's functioning in any way. A desktop computer was chosen that met the requirements of flexibility, graphics display capability, and availability to the submarine fleet. The small computer was then interfaced with the UYK-7 computer that drives the 21A40, so that values of target course and range, fire control system course and range, and signal-to-noise ratio could be sampled. The performance display system used parameters (such as target course and range) that were already familiar to the fire control party. Probability of counterdetection was also included, as a measure dependent upon both the technology of the target and the approach taken by the attack officer.

It was found that post-training analysis of exercises was greatly facilitated by the system's ability to portray events and situations that occurred during the exercises. Trainees were quickly able to see situations of which they had been unaware during the actual training run. Both trainers and trainees assessed the system very favorably in informal interviews.

Utilization/Technology Base Advance

This training enhancement system has already been put into use at the Naval Submarine Training Center, Pacific Detachment, San Diego. The possibility of installing it at Submarine Tactical Training Facilities in Hawaii and New London, Connecticut, is being discussed.

Early utilization has suggested that further benefits may be achieved if additional advantage is taken of the computational abilities of the computer to provide additional features such as "smart" targets which oppose the trainee.

Payoff/Potential

This system makes an objective record of performance available for review immediately upon completion of the training session. The feedback provided by this portable, highly flexible, and inexpensive (less than \$10K) system makes it an attractive way of adding real-time performance evaluation and feedback without changing the operation of an established training program. Use of the system with the 21A40 trainer sets a precedent for expansion into other training arenas.

INSTRUCTIONAL QUALITY INVENTORY

Need

Modern military instruction is developed according to a systematic method called Instructional Systems Development (ISD). This method includes the following steps:

1. Job/task analysis leading to specification of training objectives.
2. Development of tests to measure student progress toward the objectives.
3. Design of new instruction and/or adaptation of existing instruction to achieve the objectives.
4. Implementation of the training program.
5. Evaluation and feedback for course maintenance.

Various military activities are using this method to develop or revise many of their training courses. Consequently, it is important that quality control and/or

evaluation procedures be developed for use with ISD in order that:

- Quality can be maintained throughout instructional design, preventing errors made early in the development process from being magnified as development proceeds.
- Existing materials can be evaluated with respect to newly derived training objectives to see if they need be modified or revised.
- Performance deficiencies of course graduates can be traced to possible deficiencies in instructional materials.
- Instructional materials obtained through contract efforts can be evaluated before they are accepted.

The quality of instructional materials has always been hard to measure, since each course of instruction covers a wide range of subjects. There has never been an objective way to determine how well any given set

of training materials meets the real-Navy training requirement to effectively teach the actual skills and knowledge needed on the job.

Performing Activity and Program Elements

This project was initiated by the Navy Personnel Research and Development Center in 1977. Funding is provided under Program Elements 62757N and 63720N.

Approach and Results

An initial version of the method, developed in 1977-78, was then called the Instructional Strategies Diagnostic Profile (ISDP). It was meant to provide a scientific method for diagnosing defects in instructional materials. The method then underwent a series of reviews, tests, and modifications. A formal experiment at the Propulsion Engineering School, Great Lakes, compared materials developed with the ISDP to conventionally developed materials. A workshop of mid-level Navy course developers analyzed and tried the method out, after which it was revised and renamed the Instructional Quality Inventory (IQI).

The current IQI procedures were designed to parallel and supplement the ISD process, and are based on a system for classifying objectives, test items, and instructional presentations (the three main products of instructional development). Classification is determined according to what the student is required to do with the information he learns and what type of information the student is learning. The IQI procedures are used to (1) assess the adequacy of objectives, (2) insure that test items, objectives, and the instructional presentation are consistent with each other, and (3) analyze test items and instructional materials to determine if test items have been correctly applied.

Utilization/Technology Base Advance

The IQI is being used in course development, where it increases the reliability of the ISD process.

In deciding objectives and preparing tests, it provides a prompt means of verifying decisions, and has the effect of making ISD less an art, more a science.

Seventy workshops on IQI have been conducted at critical (operational) locations across the country. The Coast Guard Institute, Oklahoma City, Oklahoma, sponsored one of the workshops—at which Air Force personnel participated. The Air Force and Coast Guard have shown interest in determining how best to use IQI.

The Chief of Naval Education and Training (CNET) is issuing IQI as a NAVEDTRA publication, making it an official part of Navy procedures. Meanwhile, IQI is in use by the Instructional Programs Development Center (IPDC) at San Diego, where it is being applied in developing school curricula for Sonar Technicians and Data Systems Technicians. IQI is being adopted at IPDC Great Lakes.

Payoff/Potential

IQI will be of substantial use to Training Program Coordinators in evaluating programs for Naval Technical Training Command, to instructors and course writers in Navy schools, and to Contract Technical Monitors, who are responsible for materials prepared under contract.

Formal comparative tests have shown the IQI to be effective in controlling the quality of training materials, and the comments of users strongly support that finding. In addition, IQI can apparently shorten the time required for the design and development phases of ISD by from 10 to 25 percent.

IQI will improve the general quality of technical training in the Navy, with benefits in manpower management and operational readiness. It can reduce the time and cost of developing and validating training materials, and can specifically improve the quality control of training materials procured under contract.

COMPUTER-BASED TRAINING SYSTEMS

Need

As Navy systems become more complex, the training requirements problem will grow—unless we can make major improvements in the technology of training itself. Recently, computer-assisted training has been a major thrust in Navy R&D. Large improvements in the power and economy of computers have made it feasible not only to design "intelligent" computer-based systems, but to use them widely at moderate cost.

These systems can teach new information effectively, and they are especially valuable in providing frequent opportunities for drill and practice. Practice demands supervision if it is to be effective, and there are never enough highly trained personnel to give that supervision. But computers can offer one-to-one supervision at low cost. They never tire, and are ready around the clock. Computer technology will now permit computer-based instruction not only in Navy schools, but on the job ashore and on board ship. Com-

puters can assist in moving training out of expensive schools. Whether in schools or in Navy units, they can improve the quality and reliability of training and provide it on flexible schedules. Potential applications of computer-based training must be continually researched for ways to exploit the ever-changing developments in computer systems.

Performing Activity and Program Elements

This project is being performed by the Office of Naval Research (ONR) and the Defense Advanced Projects Agency (DARPA). Funding is provided under Program Elements 61153N and 62709E.

Approach and Results

This technology base area initially required the development of basic scientific knowledge about subject matter and learning. Research began in 1969, and was conducted through a series of contracts with universities and other research centers. To create "intelligent" computer-based instruction, it was first necessary to analyze the skills and knowledges to be taught, and to describe them in accurate detail. Then a more exact understanding of the human learning process itself was needed and, finally, information about the teaching strategies used by successful instructors had to be compiled. This preliminary research produced:

- Practical techniques for analyzing and representing complex subject matter.
- A descriptive model of the learning process.
- A descriptive model of the instructional process.

Finally, experience was needed in applying this knowledge to meet specific Navy training needs using specific computer hardware. Experimental use of computer instruction systems gave new data which were used to refine both the representation of that knowledge for training and the learning and instructional models.

Utilization/Technology Base Advance

This research has resulted in a general expansion of the technology for computer-based instruction, not only for the Navy but for the education field as a whole. Research conducted in individual projects was disseminated to the R&D community in Technical Reports and at annual meetings of the contractors. The results of this research have led to applied follow-on research by Navy R&D Centers. For instance, two experimental systems were recently sponsored by the Navy Personnel R&D Center (NPRDC) at San Diego. Both systems provide monitored problem-solving practice.

One, the Generalized Maintenance Trainer Simulator (GMTS), was developed at the University of Southern California. It teaches systems-level electronics troubleshooting for a wide range of equipments. Information

about the equipment is programmed into the GMTS and appears to the student as a two-dimensional display. The student can then simulate making tests, isolating components, and attempting repairs. When GMTS was tested, it was found that the proficiency of students increased, time to solve problems was reduced 50%, variability in time was reduced 80%, and the number of parts replaced unnecessarily was reduced. Questionnaires showed that the students liked GMTS and thought it was useful.

NPRDC is also using the GMTS as part of the electronic equipment maintenance training (EEMT) system that will train electronics maintenance technicians in the Class A schools. By adding three-dimensional simulated test equipment, the EEMT will teach skills that apply to a wide range of electronics equipment.

The second system sponsored by NPRDC was the Basic Instructional Program (BIP), developed at Stanford University. BIP teaches BASIC, the most widely used programming language (and a required subject at the Naval Academy). BIP monitors the student's progress in learning BASIC, and selects particular problems for each student to fit his current strengths and weaknesses. BIP was tested with 16 students at the Naval Academy, all of whom had previously failed the Academy's BASIC course. After completing BIP, 15 passed the Academy examination.

NPRDC is now developing another computer-based tutorial system for operators of steam propulsion plants, and one for Tactical Action Officers.

Payoff/Potential

Computer-based training can help to achieve a better-trained naval force, in spite of more complex hardware technology and uncertain manpower resources. It can react "intelligently" to what the student does, and drive complex operational simulations. This capability expands rapidly as computer hardware becomes cheaper, more powerful, and more portable.

Computer-based training is expected to provide better-standardized, more reliable training, packaged so that sophisticated training can be moved out of central schools and into operational units and ships. Because such systems are always "on duty," they allow flexible scheduling with better use of each trainee's time. Finally, they can make training more nearly independent of expert instructors, freeing highly trained manpower for operational duty.

Using the GMTS, to give one example, makes it possible to produce more capable maintenance technicians in the same or less time. Trainees can practice a wide range of troubleshooting tasks in less time than required when real equipment is used. Hazards to personnel are reduced, and primary mission equipment need not be used for training.

EVALUATING METHODS FOR EQUAL EMPLOYMENT OPPORTUNITY TRAINING

Need

To promote equal employment opportunity, the Navy provides training to managers of its approximately 300,000 civilian personnel. Many different approaches have been used. Until recently, little was known about the actual impact of these differing approaches and programs on hiring, evaluating, training, and promoting civilian personnel. Therefore, the Navy's Office of Civilian Personnel requested assistance to develop a system, based on objective criteria, for evaluating equal employment opportunity training efforts.

Performing Activity and Program Element

This research is performed by the Office of Naval Research (ONR). Funding is provided from Program Element 61153N.

Approach and Results

This problem was approached in three successive steps: to identify the criterion objectives, to develop a system of measurement, and, finally, to apply that system to assess specific programs.

- A comprehensive set of training program objectives was developed by analyzing Navy policies, directives, and existing curricula and by surveying selected personnel.

- A system was developed for measuring actual training programs against those objectives. That system was pretested.
- Additional research used the measurement system to assess the impacts of several different training programs.

Utilization/Technology Base Advance

The results of these efforts were (1) a tested criterion system to be used in continuing evaluation, and (2) a new understanding of the comparative effectiveness of different training approaches. This information was fed back to improve the real effectiveness of equal employment opportunity training.

The ONR-developed criterion measurement system is now in use by the Navy's civilian personnel system, where it provides the foundation for an improved training program. That program, recently instituted, will instruct managers in what is required to establish and maintain training.

Payoff/Potential

This research and the programs growing out of it will ensure that Navy training complies fully with the applicable directives, regulations, and laws. Insofar as training can do so, it will ensure that the Navy's employment practices are in fact equal.

RECRUIT TRAINING PREVIEW REDUCES ATTRITION

Need

An earlier basic research study of Marine recruits indicated that their initial expectations about life in the Marine Corps were often not realistic. It was shown that these misconceptions contributed to high drop-out rates, particularly during boot camp.

Performing Activity and Program Element

This project was carried out by the Office of Naval Research under Program Element 62763N.

Approach and Results

Previous research in industrial settings had indicated that job applicants, given realistic advance information, tended to remain on the job longer than if they were uninformed. Since the USMC needed to

reduce personnel attrition, an experimental orientation and coping program was begun to find ways to supply recruits with a realistic preview of the training experience.

Studies were performed to determine the specific points of difference between the expectations of the recruits and the actual boot camp. With the help of the Instructional TV Section of the Training Support Center, videotapes were designed that would provide an overview of training and build the recruit's confidence in his ability to complete the course. The tapes are documentary in style, featuring real Marines in the midst of actual boot training. The hardships and pain of training, along with the satisfactions, are clearly shown. Drill Instructors (DIs) explain what they do during boot camp, and why they do what they do. Finally, Marines who have successfully completed the course give their reactions.

The recruit watching these tapes becomes prepared for what he will face. He learns that he will undergo rigorous physical training, and at the same time he gains an understanding of its necessity. He is given examples in his peer group to follow, and is also given a chance to see and hear DIs from a new perspective. The young marine who may have enlisted to escape the drudgery of a classroom for the excitement of life in the Corps learns why his early days are spent taking tests and filling out forms. Through the tapes, he is able to see the "before and after" of boot camp, and to appreciate the results.

Utilization/Technology Base Advance

The films are now being used with success at Parris Island. Early results indicate that overall recruit training attrition among males who were exposed to the

films was 10%, compared to 15% for those recruits who had not viewed the films. Survey data trends also indicate that attitudes are being changed in a positive way.

Tapes have also been made that are designed especially for women recruits. New tapes are now being prepared specifically for use at the recruit depot in San Diego.

Payoff/Potential

When the tapes have been fully implemented in the boot camps, the next step will be to apply the same previewing techniques to each successive stage of Marine Corps experience. The groups of marines exposed to the films will be followed throughout their military careers to assess their relative success and length of time in the Corps.

ESTABLISHING LIAISON WITH THE NATION'S SCHOOLS

Need

During the 1970s a major shift in public education has brought about a new emphasis on "career education." Schools have incorporated materials on many jobs—their characteristics, employment opportunities, and entry requirement—into guidance programs. Military and naval careers, however, have been treated inadequately, being for the most part either ignored entirely or categorized as "public safety" jobs.

Performing Activity and Program Element

The Office of Naval Research performed both feasibility studies and material development. Funding came through Program Element 62763N.

Approach and Results

Researchers worked closely with two groups: educational administrators at Federal, state, and local levels, and the Navy Recruiting Command's "schools liaison" staff. The feasibility of incorporating the concept of "Navy as employer" into career education programs was demonstrated. Prototype material on Navy jobs was developed and later became the basis of the Recruiting Command's liaison work. Interest in the Navy on the part of guidance people was established

through an extensive series of briefings to trade unions, business groups, and educators.

Utilization/Technology Base Advance

New courses in "military career opportunities," developed from materials produced through this research, were offered to guidance counselors at the Universities of Delaware, Minnesota, New Mexico, and others. A book, *Work in the Navy*, was prepared for recruiters to use in explaining to the schools the breadth of Navy occupations, their respective demands, and their correspondence to civilian jobs. *Work in the Navy* is unique in that it clearly and accurately portrays both the positive and the negative aspects of Navy jobs, in a "tell-it-like-it-is" approach. Thus, in addition to being more informative than the usual "sales" approach, *Work in the Navy* presents recruiting (and the Navy) in a credible light. A second printing of several thousand copies of the book has been widely distributed.

Payoff/Potential

Career guidance is a relatively low-cost, very long-range way to build positive links between the Navy and the nation's youth. It helps recruiters gain legitimate access to youngsters and it provides an intelligent career option that has hitherto been ignored.

SIMULATION AND TRAINING DEVICES

DoD defines this area of People-Related RDT&E as follows:

"Development of cost effective training equipment and technology that produce the needed performance for operation and maintenance of military systems."

The Navy needs training devices and simulators for several purposes: to improve the training readiness of people; to reduce training costs; to increase safety during practice of dangerous activities; and to reduce the destructive impact of training activities on the environment. Following Congressional guidance, several program elements have been established to accomplish these objectives.

Projects in this category include:

- **Universal Infantry Weapons Trainer**
- **Advanced and Synthetic Firefighting Simulators**
- **Visual Technology Research Simulator (VTRS)**
- **Instructional Support System for Aviation Simulators**
- **A Navy-Designed Training Program for the New SH-3H Helicopter**

UNIVERSAL INFANTRY WEAPONS TRAINER

Need

Training for combat has always been difficult because there has been no realistic way to simulate the conditions of war. The Marine Corps has a special problem because Marine infantrymen must spend extended periods of time aboard ship, without access to weapons ranges or maneuver space. Even ashore, combat training is constrained by costs of munitions, scheduling problems, and a shortage of real estate. In the Reserves, tactical training is possible during only 2 weeks of the year. A training technique is needed that can be used anywhere, and that will simulate fire against a maneuvering enemy. It should require target search and selection, in the presence of distraction and stress.

Therefore, USMC asked the Naval Training Equipment Center (NTEC) to develop a simulator using electro-optical technology. The task would draw from a

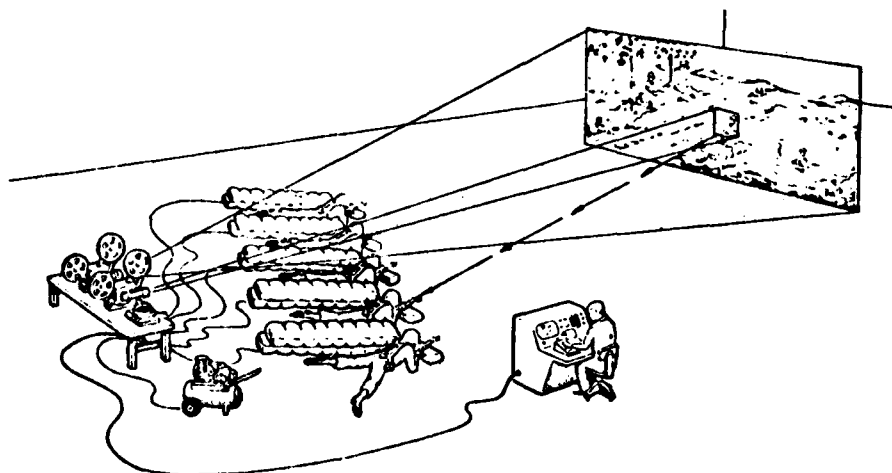
line of exploratory research which NTEC had begun in 1967. There was an existing research base, and a developing technology in weapons fire simulation on which to build. That same line of research has developed several other devices now being used in the field or undergoing tests, including the Tank Gunnery Trainer used by both the Army and the Marine Corps.

Performing Activity and Program Elements

This program is an in-house activity of NTEC. Funding is provided by program elements 62757N and 63765M.

Approach and Results

The Universal Infantry Weapons Trainer uses simulated weapons, fired at images projected on a screen and controlled by a microcomputer (see figure).



Universal Infantry Weapon Trainer

The system uses two motion picture projectors: One supplies the visual field and targets; the other provides invisible infrared target markers. Aiming "lead" is programmed into the target markers and the weapon must be pointing at a marker when fired in order to score a hit. Each of the trainees (up to a maximum of five) has a simulated weapon with a four-quadrant infrared detector attached. When the trainee fires, he hears a bang and feels a recoil. A short pulse of air released near the front sight supplies the recoil, driving the weapon high and to the right. If the weapon has been aimed correctly, the infrared spot on the screen is picked up by the detector mounted on the weapon. The infrared returns are then immediately processed by the microcomputer, which determines where the round would have hit. This information drives both a CRT (readout) display at the instructor's console and

a computer-generated voice unit. Audio comments are generated by an electronic word system to give immediate verbal feedback to either the trainee or the instructor, or both, through headsets. The computer keeps a running total of 5 scores for each shooter: reaction time, targets presented, targets shot at, targets hit, and shots taken when no target is present. The logic unit can distinguish between hits, near misses, and total misses. These data can be continuously monitored by the squad leader during the session, and are typed out afterward.

This system can present a wide range of combat scenarios realistically, including noise and simulated battlefield stress. So far, a prototype has been produced and tested to simulate the current service rifle. Advanced models are now under development for testing by the Army Infantry School and the Marine

Corps. A capability is also being developed to simulate hand-held anti-tank weapons fire (LAW/VIPER). The same universal trainer will eventually be able to simulate machinegun fire as well.

Utilization/Technology Base Advance

The Universal Infantry Weapons Trainer will be used at selected Marine and Army training centers, where it will supplement live-fire training. In particular, it will be used on board amphibious assault ships (LHAS) and other amphibious ships, and at Marine Corps Reserve Centers. The initial operating date is projected for 1982.

This project advances the technology base for use of electro-optical technology in weapons fire simulation. Two related efforts are: a Laser Marksmanship Rifle Trainer and an Air-to-Air Gunnery Trainer. All the armed services will benefit by having systems for increasingly realistic combat training.

Payoff/Potential

The principal payoff from this trainer is an ability to provide effective squad-level training in confined spaces. An improved quality of training can be expected, along with benefits in logistics, safety, and costs. Using the trainer:

- Training can be conducted at any time, without regard to scheduling or weather at specific ranges.
- There is no ammunition cost or limitation on rounds fired.
- There is no live-fire hazard.
- Training will benefit from real-time assessment and correction.

This system provides realistic visual targets in active, realistic maneuver settings. It simulates combat noise, distraction, and the stress of making fire decisions under pressure of time. Finally, the system can present a variety of combat scenarios, tactical problems, targets, and terrains.

ADVANCED AND SYNTHETIC FIREFIGHTING SIMULATORS

Need

Shipboard fires, large and small, have always been one of the greatest threats to the safety of Navy personnel. The hazard to Navy ships and operations is great. Adequate training and experience in extinguishing fires can minimize their destructiveness. Present Navy firefighting training consists of introductory firefighting experience for recruits, followed by courses at fleet firefighting or damage control schools. At the end of training, the trainees extinguish a single large bilge fire ("simulated" by burning diesel oil) taking place on a surface ship.

More extensive training is reserved for certain ship personnel: all key members of a firefighting team, ship decisionmakers, and all submarine crewmembers. They are required to undergo rigorous and repeated firefighting experiences to gain the knowledge and skills needed in making tactical firefighting decisions. Using actual fires and equipment is, of course, too costly in both money and time. But the flammable waste materials that are burned instead to simulate shipboard fires produce objectionable volumes of smoke and gaseous pollutants. Even more importantly, such fires are difficult to control for the gradations of severity that training would ideally include. To meet the need for more efficient training in this critical area, programs are being pursued to develop firefighting simulators for specific training in all classes of fires.

Performing Activity and Program Elements

This project is being performed at the Naval Training Equipment Center, Orlando, Florida. Early research was under Program Element 62757N. Present efforts are being funded under PE 64703N.

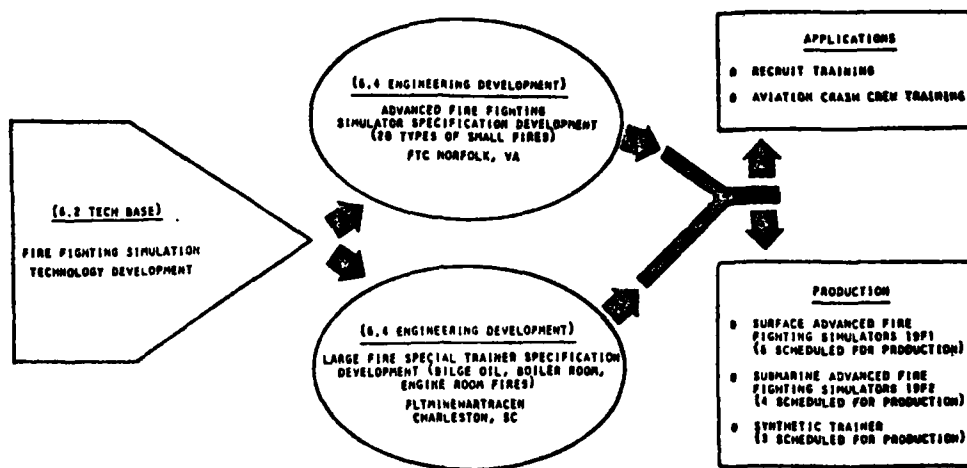
Approach and Results

An Advanced Firefighting Simulator is being developed to provide simulation of Class A (wood, cloth, paper products), Class B (small oil, fuel, cooking), and Class C (electrical) fires, using propane gas. An experimental firefighting model, completed in June 1977, consists of an array of full-sized gas burners, associated sensors, and a logic control unit. Engineering has gone forward since October 1977 on a full-scale unit.

A program to develop a Synthetic Firefighting Simulator for training in fighting large fires has begun and will be carried out in two concurrent phases: (1) A full-sized training building with a flame area size of 1000 sq. ft. will be constructed and (2) research will be performed (a) to measure and interpret flame characteristics in a large, uncontrolled diesel-fuel fire, (b) to learn the effects of correct and incorrect firefighting techniques, and (c) to recommend an interior layout of the simulator that will provide as many varieties of firefighting experience as feasible.

Development of these training systems relies on earlier exploratory development of a digital control unit, optical flame sensors, mechanical/electrical extinguishment sensors, fail-safe equipment, and

other applicable technology conducted at the Naval Training Equipment Center. The figure below shows the relationship between the earlier research and the two current programs.



Firefighting Simulators Developmental Sequence

Utilization/Technology Base Advance

By using small propane-gas fueled fire simulators to represent each class of fire, trainees can be given repeated drills in locating and extinguishing fires of many types in a variety of controlled environments. Training will be capable of rapid ignition, controlled flame intensity and height, controlled extinguishment (or rapid shutdown, if necessary), and selective receptiveness to extinguishment agents. They will also display such typical fire characteristics as flare-up, spreading, scattering, and relighting.

The Advanced Firefighter Trainer, Device 19F1, is scheduled for installation in the Firefighting Structure at the Norfolk Firefighting School's Fleet Training Center in the fall of 1979. The Synthetic Firefighting Simulator will be built and installed at the Fleet Mine Warfare Training Center, Charleston, South Carolina. A preliminary Test and Evaluation (T&E) Report on the full-scale Advanced Firefighting Simulator is scheduled for completion by February 1980, with the final report to be completed by February 1980. Acceptance tests on the Synthetic Firefighting Simulator are scheduled for March 1982.

Payoff/Potential

The need for carefully controlled environments for training in firefighting techniques is a long-standing

one. New urgency has lately been added to that need in the form of a requirement to develop non-toxic, non-polluting firefighting training environments that satisfy the criteria established by the Environmental Protection Agency (EPA) and by state and local ordinances.

The programs under development here have the potential to provide cost savings in many areas:

- The expensive afterburners can be eliminated.
- The costs of fuel will be approximately the same, but the amounts used per training exercise will be less because of the computerized operational control exercised by the instructor/operator.
- There will be far less maintenance and clean-up between successive fire restarts, which will facilitate repetition, and thus more efficient training.
- A significant reduction in cost is possible through the use of less expensive foam substitutes.
- A sharp reduction in environmental pollution will be achieved.

VISUAL TECHNOLOGY RESEARCH SIMULATOR (VTRS)

Need

For over 40 years, flight simulators have played a vital part in military aviation training. During all that time, however, their effectiveness has been limited by the difficulty of creating a realistic visual display that could move in response to simulated aircraft maneuvers. The need for better simulators is compelling. As aircraft become progressively more complex, they make heavier demands on pilot skill and knowledge while at the same time increasing the cost of flying time. Fuel shortages threaten, and DOD has resolved to reduce flying time by 25%, by 1981. It simply will not be possible to train and maintain competent aircrews without a greater dependence on simulated flight.

Navy flying presents several specialized problems: No current system can adequately simulate carrier circling approaches, carrier fixed-wing landings, or destroyer takeoffs and landings by helicopters. Furthermore, no research exists to tell us what levels of fidelity are really necessary in terms of pilot performance or training effectiveness. Aviation training programs in general need better wide-angle visual simulators for air-to-air combat, air-to-ground weapons delivery, formation flying, or for landing or maneuvering helicopters in confined areas. A few existing simulators can train parts of these tasks. But they are quite complex and expensive, and each suffers its individual drawbacks or limitations.

Flight simulators represent a substantial cost (actual hardware purchases by DOD totaled 1.3 billion dollars in 5 years). There is a clear requirement for research to assure that this outlay buys the best state of the art and the maximum pilot proficiency. To meet this need, the Navy initiated a continuing program, beginning in 1975. This effort developed a Visual Technology Research Simulator (VTRS) research facility for testing new imaging technology in flight simulators and for studying the efficient use of those devices.

Performing Activity and Program Elements

This program is performed by the Naval Training Equipment Center (NTEC). Early technology supporting this research was funded under Program Element 62757N. The present effort is funded from Program Element 63733N.

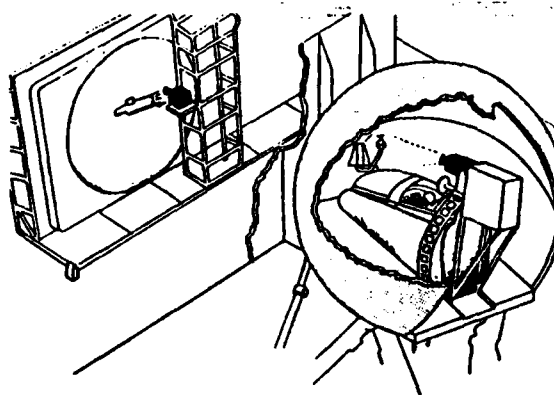
Approach and Results

Initial hardware research has explored optimized wide-angle visual displays used in a prototype trainer for conventional takeoff and landing (CTOL) aircraft. The figure below shows VTRS in use to simulate a fixed-wing carrier circling approach and landing. The visual system uses two independent television projectors, directed at a wrap-around screen. A wide-angle projector displays a background scene, on which

is superimposed a detailed target image displayed by the second projector. Controls on the image system will cause the display to move, simulating aircraft motion with a full six degrees of freedom. This facility is being used to:

- Investigate the value of new visual system technologies.
- Investigate competing alternate ways to meet performance criteria.
- Determine the behavioral effectiveness of different levels of visual fidelity.
- Experiment with image storage systems.
- Develop cockpit-motion visual control systems.
- Provide hardware design criteria for future simulator procurements.

A second wide-angle visual system will be developed to simulate vertical takeoff and landing (VTOL) flight. This system will provide the large downward viewing angles needed for hovering, and for small-deck ship operation. The VTOL visual system will be integrated with a motion system and a helicopter-type cockpit.



Aviation Wide Angle Visual System

Utilization/Technology Base Advance

Technology developed in VTRS has so far been applied in specifications for the F-14 Weapons System Trainer. As a direct result of VTRS development, the visual system of that trainer was expanded to teach carrier takeoff-and-landing training tasks. Extensions of this technology are now being applied to new Navy equipment supporting the F-18. The USAF will apply this technology in one of two competing prototypes for a fighter/attack visual system, to be added to the A-10 and F-16 simulators.

Payoff/Potential

The VTRS program will result in generally enhanced capability for Operational Flight Trainers and Weapon System Trainers, with reductions in unit cost. Secondary benefits will be felt in reduced costs for aircraft operation, improved training, and enhanced aircrew capability.

By providing improved detail and an expanded field of view, VTRS will make it possible for simulators to undertake a wider range of training tasks. Using simulators in a greater proportion of the training syllabus can reduce the requirement for training flights, permitting increased practice and more proficient fliers.

VTRS is developing new engineering concepts for visual simulation that will offer the same or better visual capabilities at lower cost. This will result in decreased procurement and lower life-cycle system costs. Finally, VTRS human factors experiments will lead to better understanding of what the skill and training payoffs are for any specific level of technique and fidelity. This will lead to better-informed decisions in buying trainers for specific learning objectives. The result will be both reduced unit costs and improved human performance. VTRS will advance the technology of visual simulation and image storage across the board, with additional payoffs in other areas such as the simulation of ground combat.

INSTRUCTIONAL SUPPORT SYSTEM FOR AVIATION SIMULATORS

Need

The value of aviation simulators is generally recognized. Naval Air Forces depend increasingly on Operational Flight Trainers (OFTs) and Weapons System Trainers (WSTs) to train aircrews and to maintain their proficiency at an acceptable cost. The Navy's dependence on simulators grows as weapons systems become more complex and as training time in operational aircraft becomes harder to justify. But while simulators are less expensive than aircraft, they are still expensive to buy and use. Even though the Navy and Marine Corps now spend about \$125 million each year for aviation simulators, effective instructional time remains limited. It is therefore essential to study the management of OFTs and WSTs and to find how their use can be improved.

Several related questions have been suggested for research. These include:

- How cost effective is the match between simulators and training objectives? Could different hardware meet those objectives more fully or at lower cost?
- In particular, is the level of fidelity that a simulator provides really required? We tend to design simulators for realism-but we have little research to prove that any degree of realism is, or is not, worth what it costs.
- Are instructors efficiently used? Perhaps not. For one thing, about 20% of their time is spent in "housekeeping" tasks, such as recording data or computing scores-duties which might be performed by automation.

- Much instructor time is spent in one-on-one student supervision. Could automated individual instruction reduce the cost of instructor time?
- A typical session follows a syllabus designed for the average student's capability. Can more learning occur in less time if each session is fitted to the individual aircrewman's needs through better measurement and individualized, adaptive instruction?
- Are there better and quicker ways to upgrade the skills of instructors in using simulators?

Most of these questions could probably be answered "yes" if research data were available. Computer technology now provides a practical way to collect the research data and to test automated individual instruction. Needs expressed by the Commander of the Pacific naval air fleet (COMNAVAIRPAC) and requirements submitted by the Chief of Naval Operations (CNO) led to an Operational Requirement in 1975.

Performing Activity and Program Elements

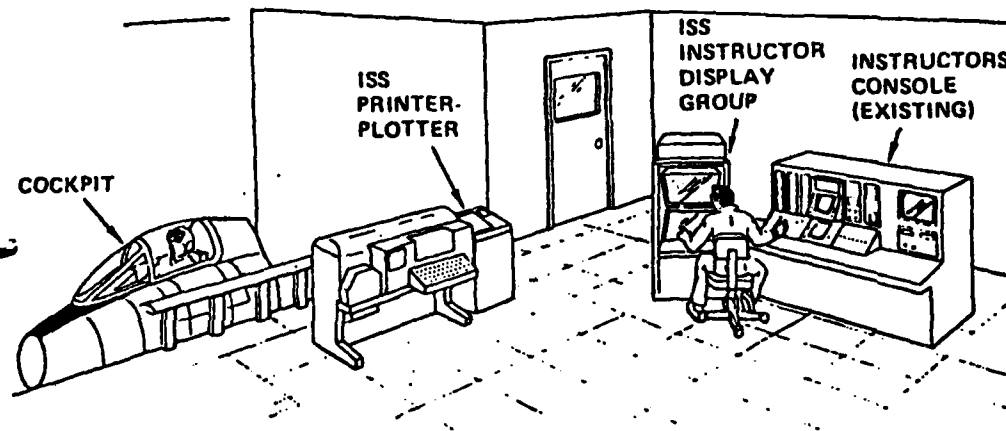
This project is being performed by the Naval Training Equipment Center (NTEC). Funding for preliminary research was provided from Program Element 62757N. Funding for current development is from Program Element 64703N.

Approach and Results

This effort will develop, test, and evaluate an experimental prototype Instructor Support System (ISS).

which is a computer management, data recording and control package connected to a working OFT or WST host simulator (see figure). It will be in functional communication with the host simulator, controlling the operation of the simulator and recording data from

each training session. All hardware (except for an interface package) is commercially available equipment, so the emphasis will be on the design of techniques by which the instructors may use the ISS, and the writing of computer software.



F-14 OFT Training Area with ISS Equipment

This development is based on prior research and experience in the Navy and USAF. Original research by the Human Factors Laboratory at NTEC was implemented by the USAF in their Automated Flight Training System (AFTS) and used with an F-4E simulator at Luke AFB, Arizona. Evaluations conducted there, and by the Navy at NAS Chase, Texas, demonstrated that automated individualized training was possible and could relieve instructors of routine tasks without any loss to training. The prototype package developed here expands the AFTS concept to include four major new features:

- It can conduct on-line training for instructors.
- The instructor can vary the degree of automated support he desires.
- The system can improve its own effectiveness by "learning" from experience.
- Modifications can easily be made as needed for experimental research.

Utilization/Technology Base Advance

Upon delivery, the ISS package will be installed at Miramar, California, for first-phase testing. It will support replacement pilot training in VF-124, the F-14 Fleet Readiness Training Squadron. There it will be attached to the F-14A OFT for a period of tuning, operability testing, and evaluation. Based on these

tests, a decision will be made whether to proceed to a WST phase for the F-14. A period of test and evaluation would follow, and results would be used to specify designs for production models of the ISS.

This effort continues a line of research by which the Navy and USAF have jointly advanced flight simulator technology away from isolated device procurement and toward a cost-effective, systems-design approach. Earlier work provided a limited capability for automated instruction and data support, plus empirical data to use in specifying new simulator designs. The current effort will explore that earlier work at a high but cost-effective level of computer technology.

Payoff/Potential

If successful in reaching a production phase, the ISS will be widely used in Navy and other aviation training programs. It will provide early benefits in upgraded instructor effectiveness, in more efficient use of instructor time, and in making possible flexible interactive automated training for fliers. It will immediately begin to provide a rich R&D data base for improving the management of flight simulators. In particular, it will permit us to replace the present intuitively designed simulators with new-generation simulators, which will be more exactly fitted to the needs of training and will use a level of fidelity that is known to be cost effective.

A NAVY-DESIGNED TRAINING PROGRAM FOR THE NEW SH-3H HELICOPTER

Need

A new and more efficient training program was needed to accompany fleet introduction of the SH-3H Model helicopter. The upcoming delivery of a state-of-the-art weapons system trainer (WST) and a requirement that additional anti-submarine warfare (ASW) and aircraft systems training be absorbed within current instructor manning levels also dictated that major changes be made to existing pilot and aircrewman training programs. The modified training programs would have to maximize available resources and effectively integrate the training system, including the new WST.

Performing Activities and Program Element

This project was initiated by Helicopter Anti-Submarine Warfare Squadron Ten (HS-10), Naval Air Station, North Island, with technical assistance being provided by the Naval Personnel Research and Development Center. Funding was provided from Operation and Maintenance funds of the Naval Air Systems Command.

Approach and Results

The general methodology referred to as "Instructional Systems Development" (ISD) was used in the design, development, and implementation of the HS-10 training courses and in the use of the training device. While this approach has been successfully employed in the development of related Aviation Operator training systems, the HS-10 effort represents the first attempt to implement an ISD program without direct contractor support. Navy subject-matter experts (SMEs), under the guidance and direction of an NPRDC Instructional Research Psychologist and with the support of local media production organizations, were able to establish training courses fully comparable to those developed under contractor assistance. The project generated a variety of student self-study materials, including workbooks, tape/slide, and videotape programs. It also produced all tests and all simulator and flight exercises.

Utilization/Technology Base Advance

The HS-10 replacement pilot and aircrewman training programs were implemented in early 1978

and are presently being delivered to the East Coast SH-3H training readiness squadron (HS-1) for implementation in late 1979.

As a direct result of this effort, the Navy has gained considerable knowledge about the "self-help" approach to implementing the ISD methodology in aircrew training and training devices. While it has been possible before to evaluate the costs associated with contractor-developed training, prior to this effort few hard figures were available to indicate the actual costs involved where uniformed subject-matter experts were used. Another unknown was the degree of technical quality that might be expected from an all-military instructional development team. This project has now provided experience by which such evaluations can be made in the future.

Payoff/Potential

Applications of the ISD approach have been partially validated and the following benefits identified:

- A potential 25% increase in student throughput rate.
- A potential 40% reduction in acquisition costs as compared to traditional training programs.
- A potential 30% saving in life-cycle support costs.
- Increased training efficiency due to greater flexibility in student training scheduling, decreased aircraft training flight time, reduced overall training time, and more standardization.
- Integration of the instructor, students, and training devices into a total training system able to meet stated training objectives more cost-effectively.
- Operational Fleet air personnel have stated that ISD program graduates reaching the Fleet are as effective as those with two years of experience.

The additional cost, training, and personnel-requirements information acquired as a result of this Navy self-help effort is expected to allow planners and decisionmakers to use available resources more effectively in developing and upgrading existing aircrew training.

R&D COORDINATION

Program coordination and technology exchange between the Services has been improving significantly during the past several years. Technical and program coordination is being provided through formal working groups, ranging from groups having broad technical exchange interests to interorganizational Memoranda of Agreement to provide for close coordination of specific efforts. The Navy has been very supportive of tri-service cooperation. Pertinent coordination efforts described in this final section are:

- The 1979 Interservice Conference for the Coordination of People-Related R&D
- Technology Advisory Group (TAG)
- Technology Exchange
- Top Management Action to Enhance Utilization of People-Related RD&E

THE 1979 INTERSERVICE CONFERENCE FOR THE COORDINATION OF PEOPLE-RELATED R&D

The Navy Personnel Research and Development Center (NPRDC) sponsored this three-day interservice conference, which took place in February of this year with participants including commanding officers and technical directors of people-related R&D laboratories and key Headquarters personnel. Twelve research laboratories were represented, covering all 34 program elements in this program. The objectives of the conference were:

1. To provide an informal, highly participatory forum for the discussion of ideas and the exchange of information on the critical "people issues" facing the Department of Defense and each of the military services.
2. To begin an analytical critique of management and technical problems facing military laboratories engaged in people-related R&D.

3. To review, evaluate, and propose what the military services might do jointly to improve the management and coordination of people-related research and development.

This conference represented the first time that all training and personnel laboratory decisionmakers had sat down together to openly discuss coordination, cooperation, and how to work as a team. A series of informal group workshops proved highly effective as the vehicle for discussion of these R&D issues. One significant result of the conference was a total agreement to categorize every project in the people-related program according to a matrix relating DOD issues and needs to four categories: (Manpower & Personnel Technology; Human Factors; Education & Training; and Training Devices and Simulation).

TECHNOLOGY ADVISORY GROUP (TAG)

A tri-service Technology Advisory/Coordination Group has been established for each major category within the Training and Personnel Technology programs. The major categories of the Training and Personnel Technology programs are Manpower and Personnel Technology, Human Factors in Weapon Systems, Education and Training, and Training De-

vices and Simulation. The TAGs are working-level (laboratory) groups whose objectives are to (1) reduce the number of smaller special interest groups, (2) provide peer review, (3) identify and initiate cooperative and collaborative research programs, (4) provide professional growth, and (5) increase technology transfer.

TECHNOLOGY EXCHANGE

A Training and Personnel Technology Conference (TPTC) was established in November 1976. The TPTC meets whenever emerging developments in DOD RDT&E give rise to a need for further coordination. It has served as an effective forum for the review and discussion of selected areas of RDT&E in this technology area among senior RDT&E managers/users, to identify any R&D deficiencies and management issues. Minutes of the meeting are distributed. The 14th TPTC was held on 7 December 1978, on the subject of Computer Adaptive Testing.

The area of training devices and simulation is being well coordinated. The Army's project manager for Training Devices (PMTRADE) is co-located with the Navy Training Equipment Center (NTEC) in Orlando, Florida. The Marine Corps and the Air Force have a liaison officer at NTEC. In addition, the Navy has a liaison officer at both the Air Force Human Resources Laboratory (AFHRL) Flying Training Division and at the Simulator System Project Office (SPO), Wright-Patterson Air Force Base, to facilitate coordination and technology transfer efforts.

TOP MANAGEMENT ACTION TO ENHANCE UTILIZATION OF PEOPLE-RELATED R&D

The Department of the Navy has assigned a coordination role to the Deputy Chief of Naval Operations (Manpower, Personnel, and Training) to ensure development of proper requirements for research and development, and the employment and utilization of its results. A research and development steering group has been established to advise and assist the Deputy Chief of Naval Operations (Manpower, Personnel, and Training) in stating requirements and improving utilization of the Navy people-related R&D program. The primary areas of concern for this program are manpower and personnel, training, train-

ing devices, and human factors engineering. The R&D Steering Group has been charged with the following functional responsibilities:

1. To identify and set priorities for research, development, and studies.
2. To evaluate the potential application of research, development, and studies to Navy manpower, personnel, and training programs.
3. To coordinate action to implement results of research, development, and studies.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM									
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER									
4. TITLE (and Subtitle) THE 2nd ANNUAL REPORT ON THE UTILIZATION OF PEOPLE-RELATED NAVY RDT&E: FY 1978		5. TYPE OF REPORT & PERIOD COVERED Final: FY 1978									
7. AUTHOR(s) Harold E. Price (Ed.) Franklin F. Sands (Ed.)		6. PERFORMING ORG. REPORT NUMBER N/A									
9. PERFORMING ORGANIZATION NAME AND ADDRESS BioTechnology, Inc. 3027 Rosemary Lane Falls Church, Virginia 22042		8. CONTRACT OR GRANT NUMBER(s) N00244-79-C-1764									
11. CONTROLLING OFFICE NAME AND ADDRESS Navy Personnel Research and Development Center Code 9201 San Diego, California 92152		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS N/A									
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE April 1979									
		13. NUMBER OF PAGES 60									
		15. SECURITY CLASS. (of this report) Unclassified									
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A									
16. DISTRIBUTION STATEMENT (of this Report) Distribution Unlimited											
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) N/A											
18. SUPPLEMENTARY NOTES											
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) <table border="0"> <tr> <td>People-Related R&D</td> <td>Human Factors Engineering</td> <td>Simulators</td> </tr> <tr> <td>Manpower</td> <td>Education</td> <td>Navy</td> </tr> <tr> <td>Personnel</td> <td>Training</td> <td>Utilization</td> </tr> </table>			People-Related R&D	Human Factors Engineering	Simulators	Manpower	Education	Navy	Personnel	Training	Utilization
People-Related R&D	Human Factors Engineering	Simulators									
Manpower	Education	Navy									
Personnel	Training	Utilization									
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) <p>This is the second annual report of the utilization of people-related Navy RDT&E. It includes examples of both utilization and technology base advancement, primarily from FY 78. The examples are organized within four technical areas: Manpower and Personnel, Human Factors Engineering, Education and Training, and Simulation and Training Devices. Each example is discussed in terms of Need, Performing Activity and Program Element, Approach and Results, Utilization/Technology Base Advance, and Payoff/Potential.</p>											

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPRODUCED AT GOVERNMENT EXPENSE